

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Shinya Adachi et al.
Serial No.: 10/509,315
Filed: September 27, 2004
Title: "MAP MATCHING METHOD, MAP MATCHING
DEVICE, DATABASE FOR SHAPE MATCHING, AND
SHAPE MATCHING DEVICE"
Docket No.: 37079

LETTER

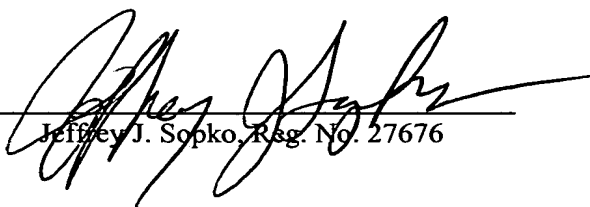
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Sir/Madam:

Enclosed herewith are 65 sheets of formal drawings for filing in the above-identified application. Please note that applicant has not yet received a Notification to Missing Requirements.

Respectfully submitted,

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October 19, 2004

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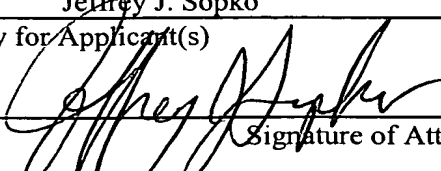
| | |
|-----------------------------------|--|
| Jeffrey J. Sopko | |
| Name of Attorney for Applicant(s) | |
| 10/19/2004 |  |
| Date | Signature of Attorney |

FIG. 1

| | |
|---|--|
| HEADER INFORMATION (SECTION DEFINITION ETC.) | |
| TOTAL NODE NUMBER N | |
| NODE NUMBER 1 | |
| NODE ATTRIBUTE INFORMATION OF NODE 1 | |
| LONGITUDE OF NODE 1 | LATITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #1 | LINK NUMBER #1-1 |
| : | |
| CONNECTION NODE NUMBER #m | LINK NUMBER #1-m |
| : | |
| NODE NUMBER N | |
| NODE ATTRIBUTE INFORMATION OF NODE N | |
| LONGITUDE OF NODE N | LATITUDE OF NODE N |
| TOTAL NUMBER OF NODES CONNECTED TO NODE N | |
| CONNECTION NODE NUMBER #1 | LINK NUMBER #N-1 |
| : | |
| CONNECTION NODE NUMBER #m | LINK NUMBER #N-m |
| TOTAL LINK NUMBER L | |
| LINK NUMBER 1 | |
| ROAD ATTRIBUTE INFORMATION OF LINK 1 | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK 1 | |
| LONGITUDE OF INTERPOLATION POINT 1-1 | LATITUDE OF INTERPOLATION POINT 1-1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT 1-p | LATITUDE OF INTERPOLATION POINT 1-p |
| : | |
| LINK NUMBER L | |
| ROAD ATTRIBUTE INFORMATION OF LINK L | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK L | |
| LONGITUDE OF INTERPOLATION POINT L-1 | LATITUDE OF INTERPOLATION POINT L-1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT L-p | LATITUDE OF INTERPOLATION POINT L-p |

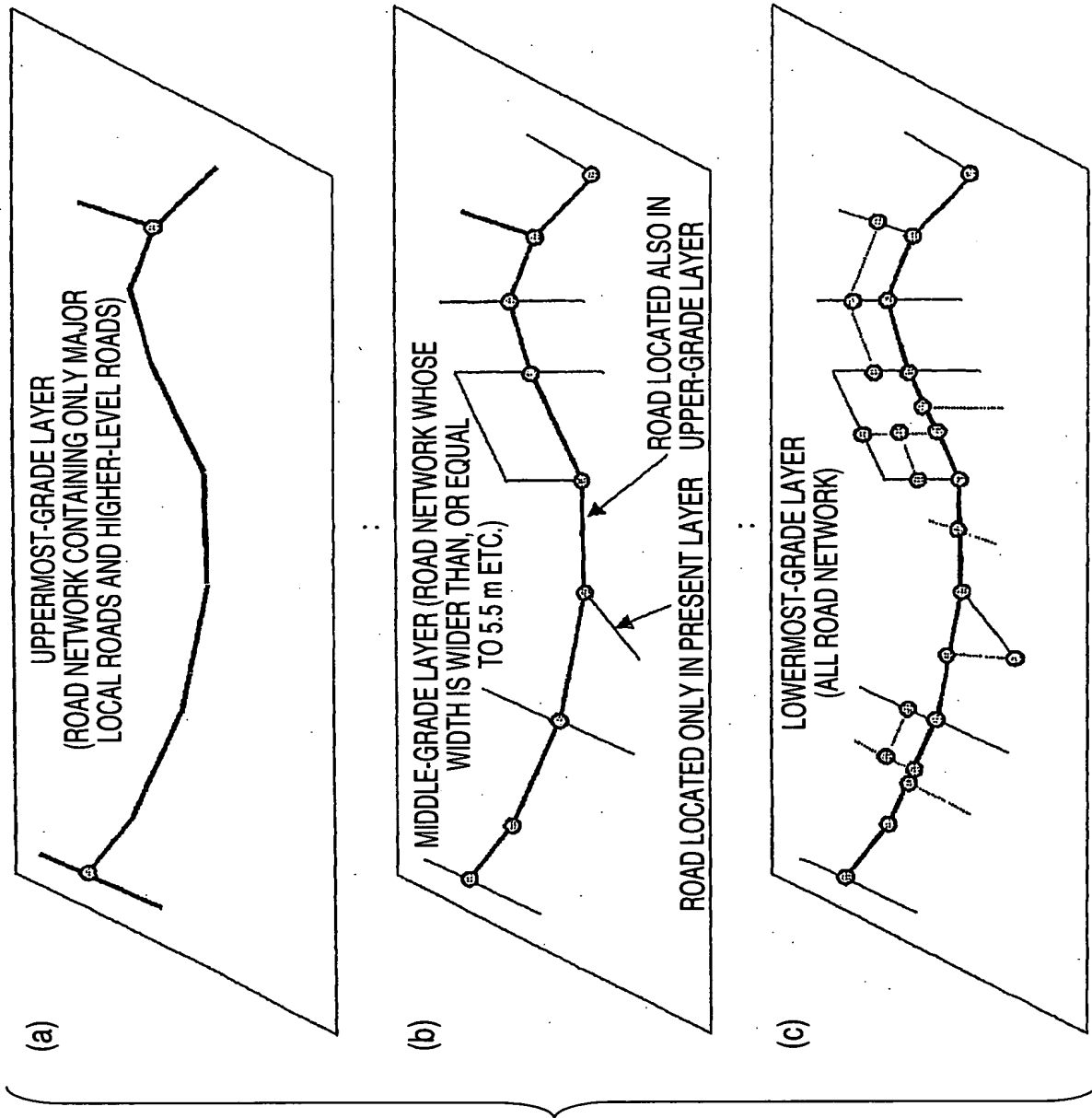


FIG. 2

FIG. 3

(a) UPPER-GRADE ROAD NETWORK DATA

| HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.) | |
|---|--|
| TOTAL NODE NUMBER N1 | |
| NODE NUMBER 1 | |
| NODE ATTRIBUTE INFORMATION OF NODE 1 | |
| LATITUDE OF NODE 1 | LONGITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #J1 | LINK NUMBER #J1-1 |
| : | |
| CONNECTION NODE NUMBER #Jm | LINK NUMBER #J1-m |
| : | |
| NODE NUMBER S | |
| NODE ATTRIBUTE INFORMATION OF NODE S | |
| LONGITUDE OF NODE S | LATITUDE OF NODE S |
| TOTAL NUMBER OF NODES CONNECTED TO NODE S (=1) | |
| CONNECTION NODE NUMBER #J1 | LINK NUMBER #SJ1 |
| : | |
| TOTAL LINK NUMBER L1 | |
| LINK NUMBER A | |
| ROAD ATTRIBUTE INFORMATION OF LINK A | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK A | |
| LONGITUDE OF INTERPOLATION POINT A-1 | LATITUDE OF INTERPOLATION POINT A-1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT A-p | LATITUDE OF INTERPOLATION POINT A-p |
| : | |
| LINK NUMBER SJ1 | |
| ROAD ATTRIBUTE INFORMATION OF LINK SJ1 | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SJ1 | |
| LONGITUDE OF INTERPOLATION POINT 1 | LATITUDE OF INTERPOLATION POINT 1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT p | LATITUDE OF INTERPOLATION POINT p |
| : | |

(CONT.)

(b)

MIDDLE-GRADE ROAD NETWORK DATA

| HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.) | |
|---|--|
| TOTAL NODE NUMBER N2 | |
| NODE NUMBER 1 | |
| NODE ATTRIBUTE INFORMATION OF NODE 1 | |
| LATITUDE OF NODE 1 | LONGITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #K1 | LINK NUMBER #K1-1 |
| : | |
| CONNECTION NODE NUMBER #Km | LINK NUMBER #K1-m |
| : | |
| NODE NUMBER S | |
| NODE ATTRIBUTE INFORMATION OF NODE S | |
| LONGITUDE OF NODE S | LATITUDE OF NODE S |
| TOTAL NUMBER OF NODES CONNECTED TO NODE S (=2) | |
| CONNECTION NODE NUMBER #K1 | LINK NUMBER #SK1 |
| CONNECTION NODE NUMBER #K2 | LINK NUMBER #SK2 |
| : | |
| TOTAL LINK NUMBER L2 | |
| LINK NUMBER B | |
| ROAD ATTRIBUTE INFORMATION OF LINK B | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK B | |
| LONGITUDE OF INTERPOLATION POINT B-1 | LATITUDE OF INTERPOLATION POINT B-1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT B-p | LATITUDE OF INTERPOLATION POINT B-p |
| : | |
| LINK NUMBER SK2 | |
| ROAD ATTRIBUTE INFORMATION OF LINK SK2 | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SK2 | |
| LONGITUDE OF INTERPOLATION POINT 1 | LATITUDE OF INTERPOLATION POINT 1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT q | LATITUDE OF INTERPOLATION POINT q |
| : | |

(FIG. 3 CONTINUED)

(CONT.)

(c)

LOWER-GRADE ROAD NETWORK DATA

| | |
|---|--|
| HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.) | |
| TOTAL NODE NUMBER N3 | |
| NODE NUMBER 1 | |
| NODE ATTRIBUTE INFORMATION OF NODE 1 | |
| LATITUDE OF NODE 1 | LONGITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #1 | LINK NUMBER #1-1 |
| : | |
| CONNECTION NODE NUMBER #m | LINK NUMBER #1-m |
| : | |
| NODE NUMBER S | |
| NODE ATTRIBUTE INFORMATION OF NODE S | |
| LONGITUDE OF NODE S | LATITUDE OF NODE S |
| TOTAL NUMBER OF NODES CONNECTED TO NODE S (=3) | |
| CONNECTION NODE NUMBER #M1 | LINK NUMBER #SM1 |
| CONNECTION NODE NUMBER #M2 | LINK NUMBER #SM2 |
| CONNECTION NODE NUMBER #M3 | LINK NUMBER #SM3 |
| : | |
| TOTAL LINK NUMBER L3 | |
| LINK NUMBER C | |
| ROAD ATTRIBUTE INFORMATION OF LINK C | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK C | |
| LONGITUDE OF INTERPOLATION POINT C-1 | LATITUDE OF INTERPOLATION POINT C-1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT C-p | LATITUDE OF INTERPOLATION POINT C-p |
| : | |
| LINK NUMBER SM2 | |
| ROAD ATTRIBUTE INFORMATION OF LINK SM2 | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SM2 | |
| LONGITUDE OF INTERPOLATION POINT 1 | LATITUDE OF INTERPOLATION POINT 1 |
| : | |
| LONGITUDE OF INTERPOLATION POINT r | LATITUDE OF INTERPOLATION POINT r |
| : | |

(FIG. 3(b) CONTINUED)

FIG. 4

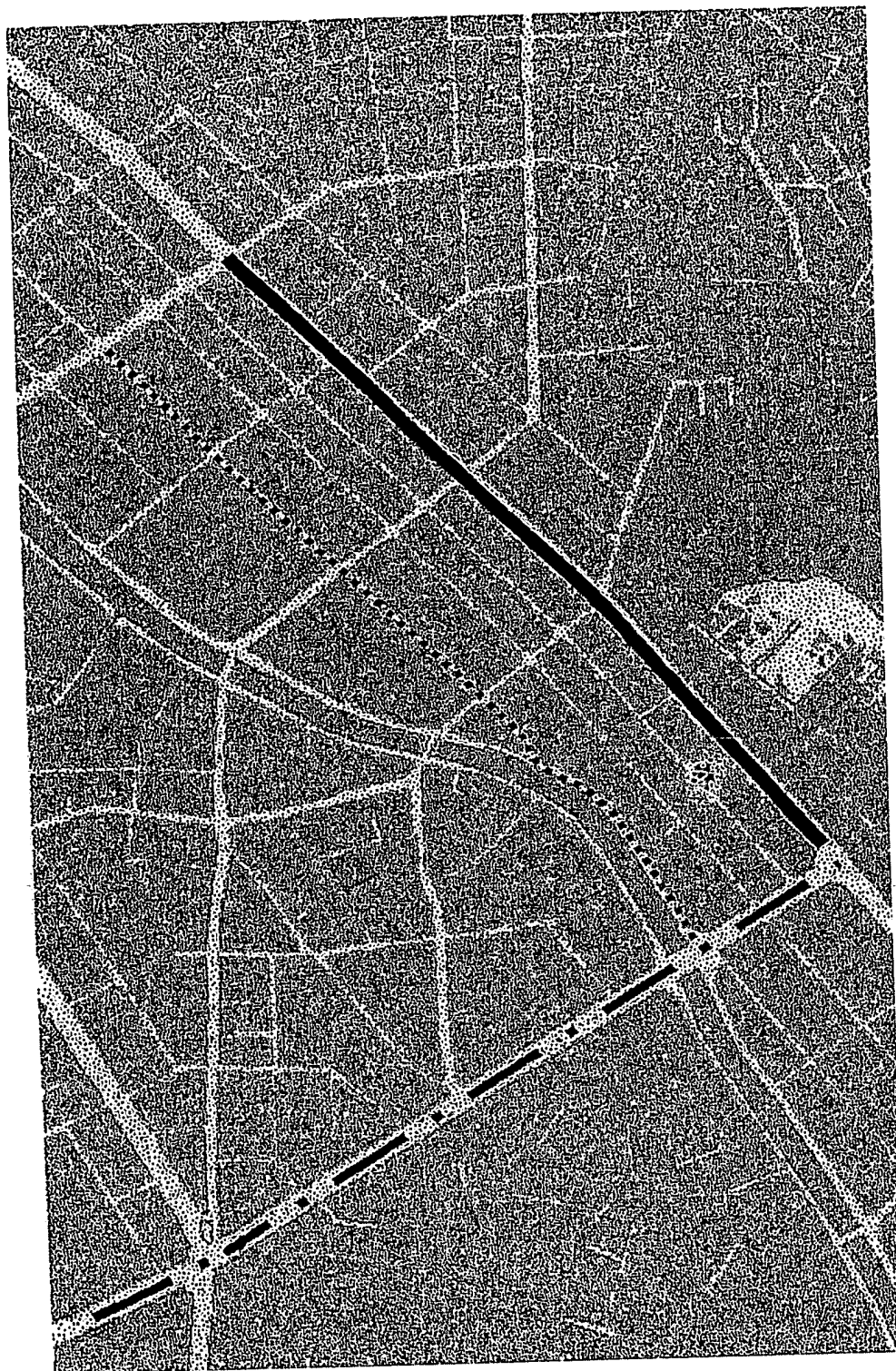


FIG. 5

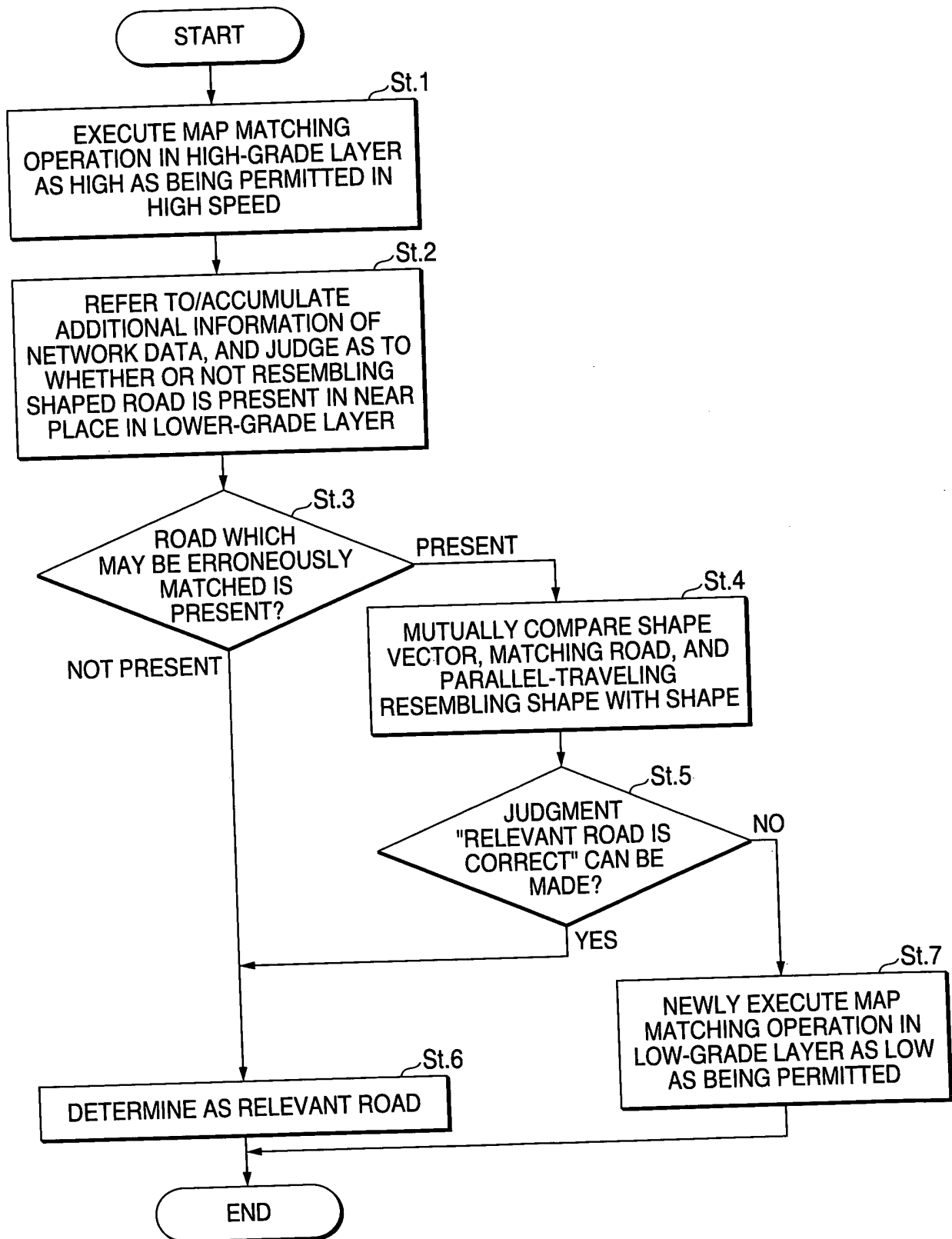


FIG. 6

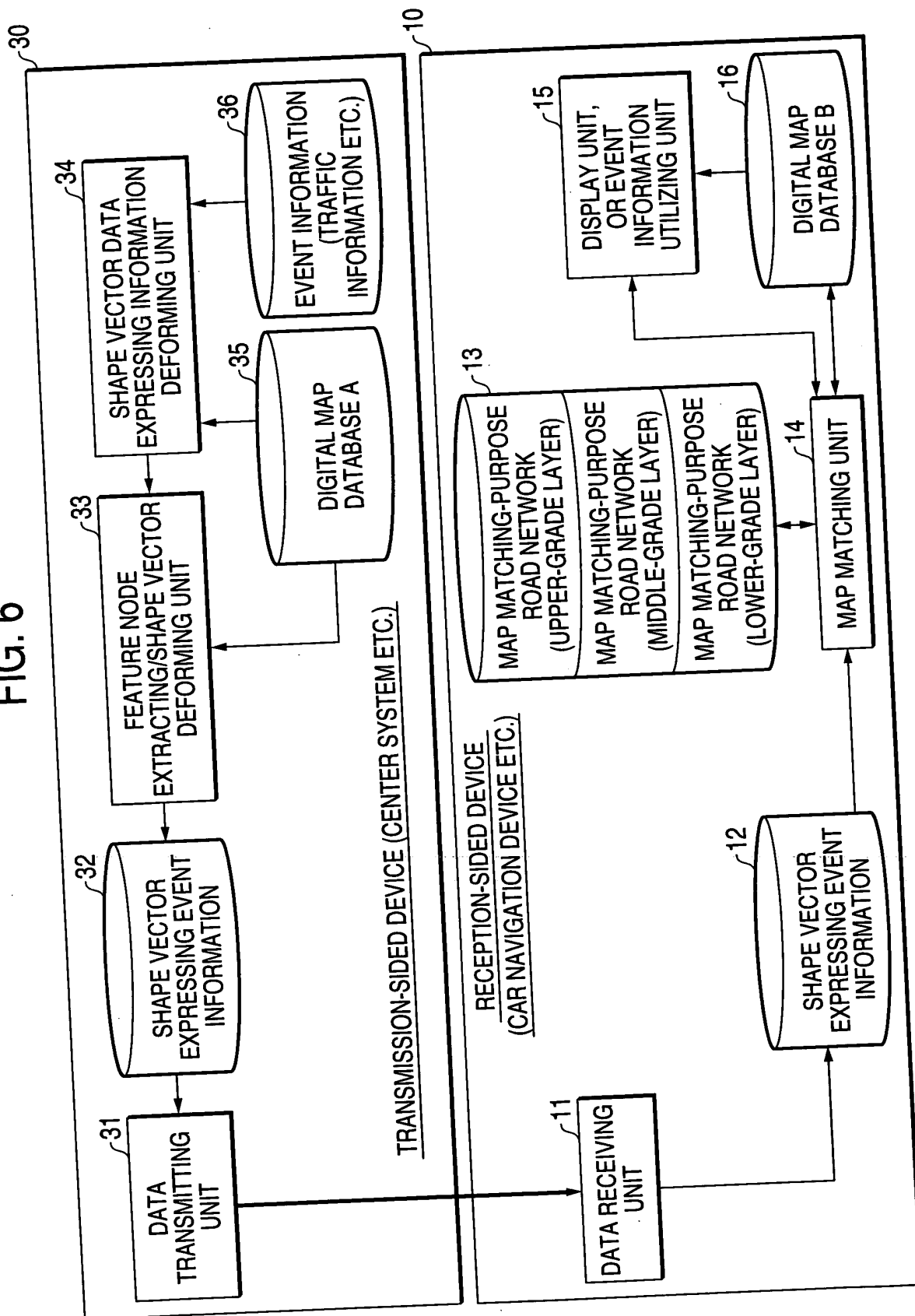


FIG. 7

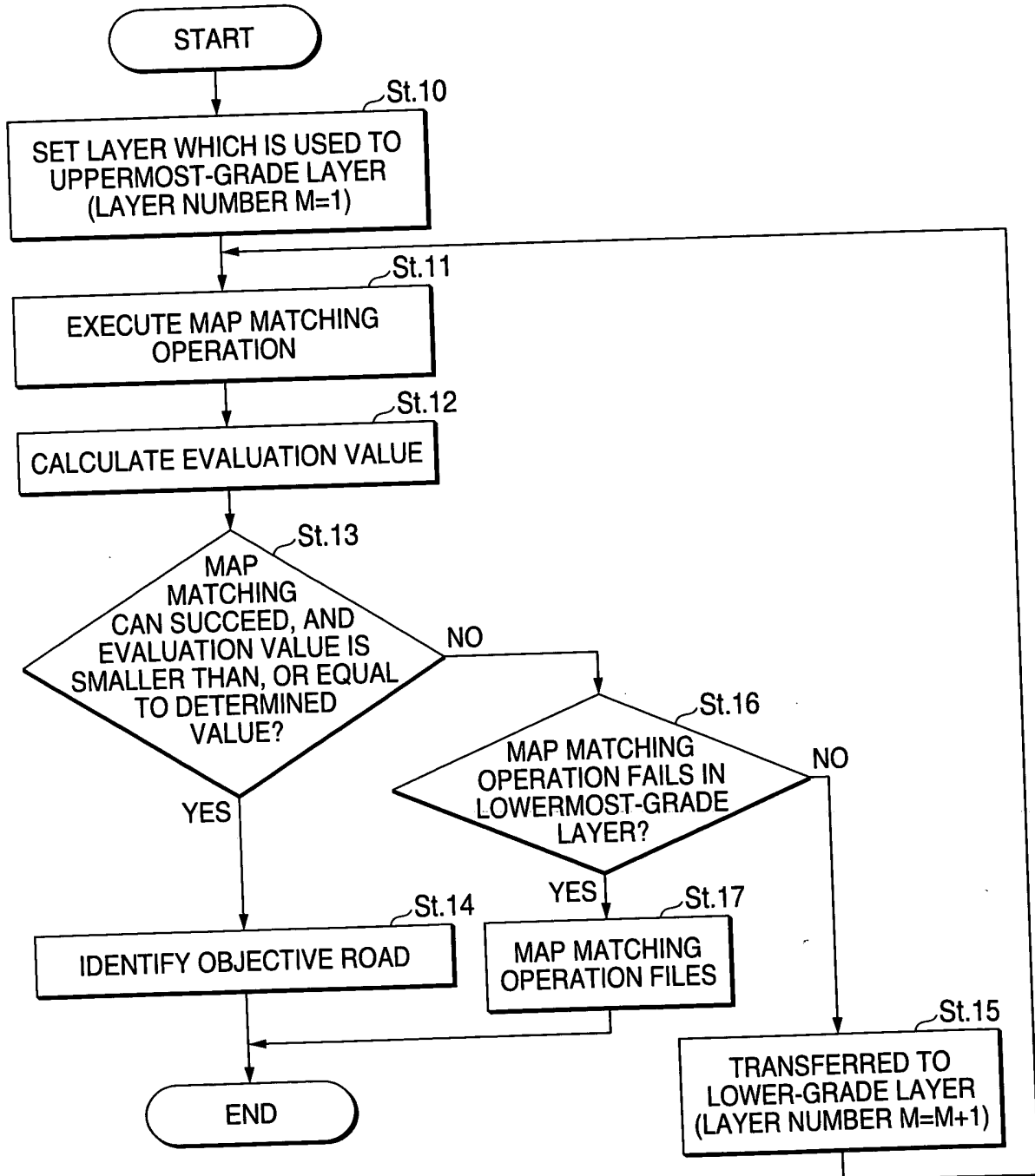


FIG. 8

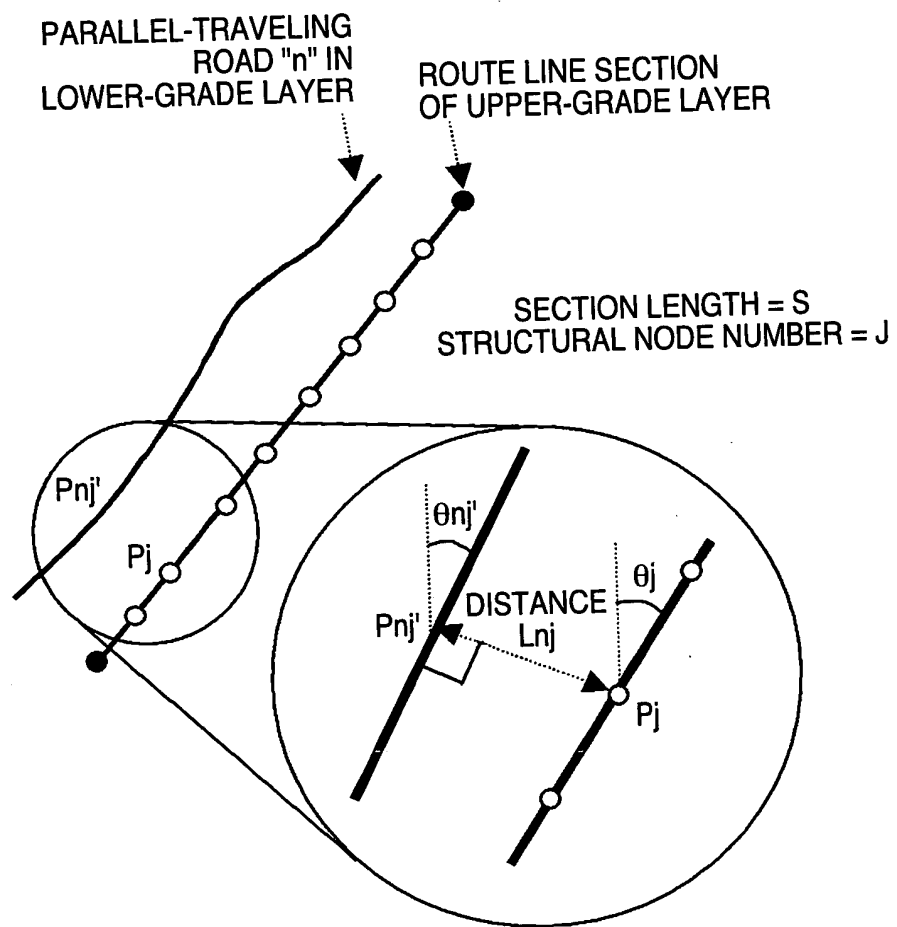
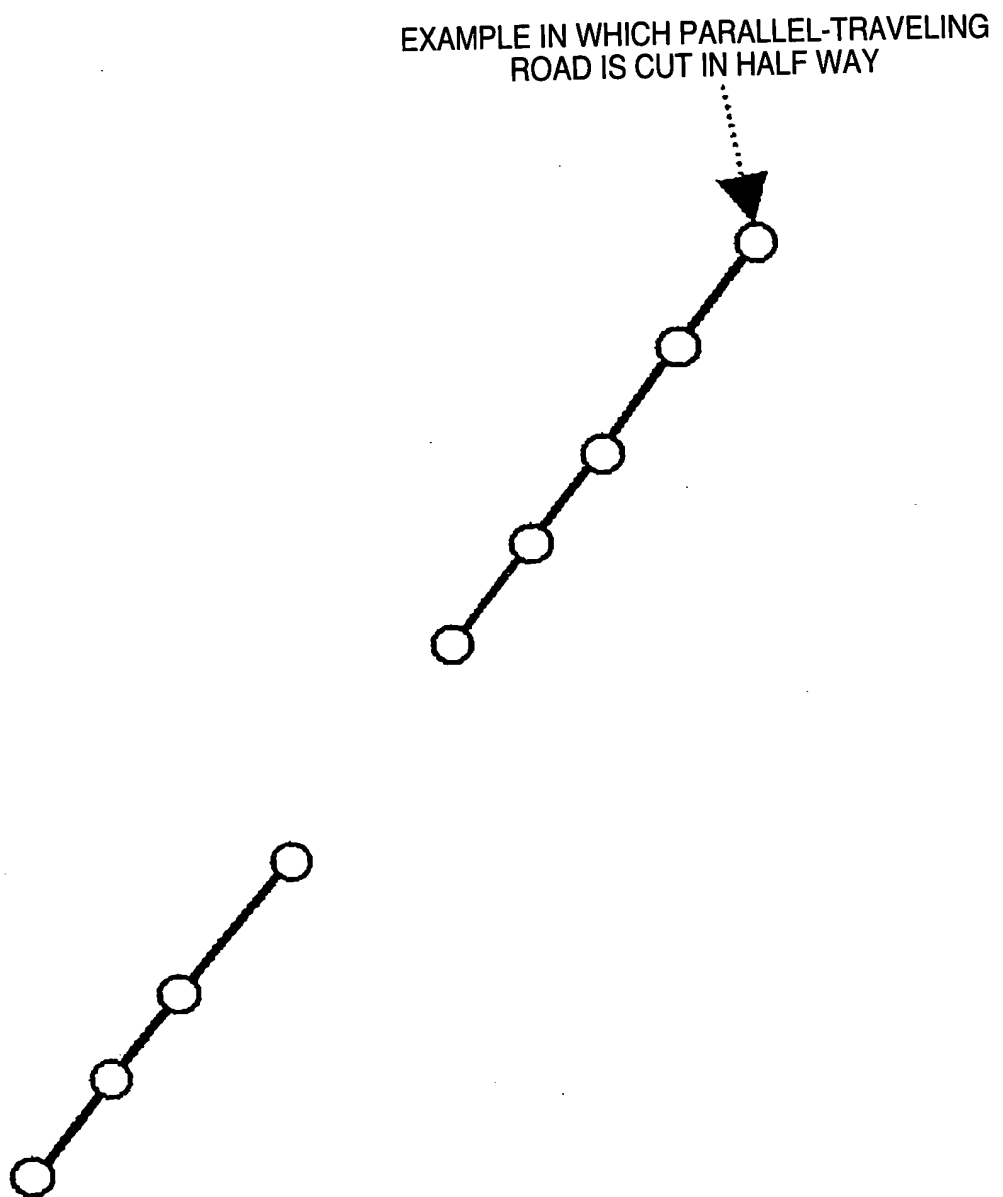


FIG. 9



12/65

FIG. 10

EXAMPLE OF MAP MATCHING PURPOSE ROAD NETWORK DATA

(a)

| | |
|---|--|
| HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.) | |
| TOTAL NODE NUMBER N | |
| NODE NUMBER 1 | |
| ATTRIBUTE INFORMATION OF NODE 1 | |
| LONGITUDE OF NODE 1 | LATITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #1 | LINK NUMBER #1-1 |
| ⋮ | |
| CONNECTION NODE NUMBER #m | LINK NUMBER #1-m |
| ⋮ | |
| TOTAL LINK NUMBER L | |
| LINK NUMBER 1 | |
| ROAD ATTRIBUTE INFORMATION OF LINK 1 | |
| PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK 1 | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK 1 | |
| LONGITUDE OF INTERPOLATION POINT 1-1 | LATITUDE OF INTERPOLATION POINT 1-1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT 1-p | LATITUDE OF INTERPOLATION POINT 1-p |
| ⋮ | |
| LINK NUMBER L | |
| ROAD ATTRIBUTE INFORMATION OF LINK L | |
| PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK L | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK L | |
| LONGITUDE OF INTERPOLATION POINT L-1 | LATITUDE OF INTERPOLATION POINT L-1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT L-p | LATITUDE OF INTERPOLATION POINT L-p |

(CONT.)

(FIG. 10 CONTINUED)

(b) PARALLEL-TRAVELING RESEMBLING SHAPED ROAD
 PRESENCE/ABSENCE INFORMATION
 (IN CASE THAT ONE DIRECTION IS REPRESENTED BY 1 LINK)

| |
|---|
| PRESENCE/ABSENCE OF PARALLEL-TRAVELING RESEMBLING SHAPE (PRESENCE/PRESENCE IN PARTIAL SECTION/ABSENCE) |
| CONNECTION/NON-CONNECTION AT UP/DOWN-STREAM SIDED INTERSECTIONS |

FIG. 11

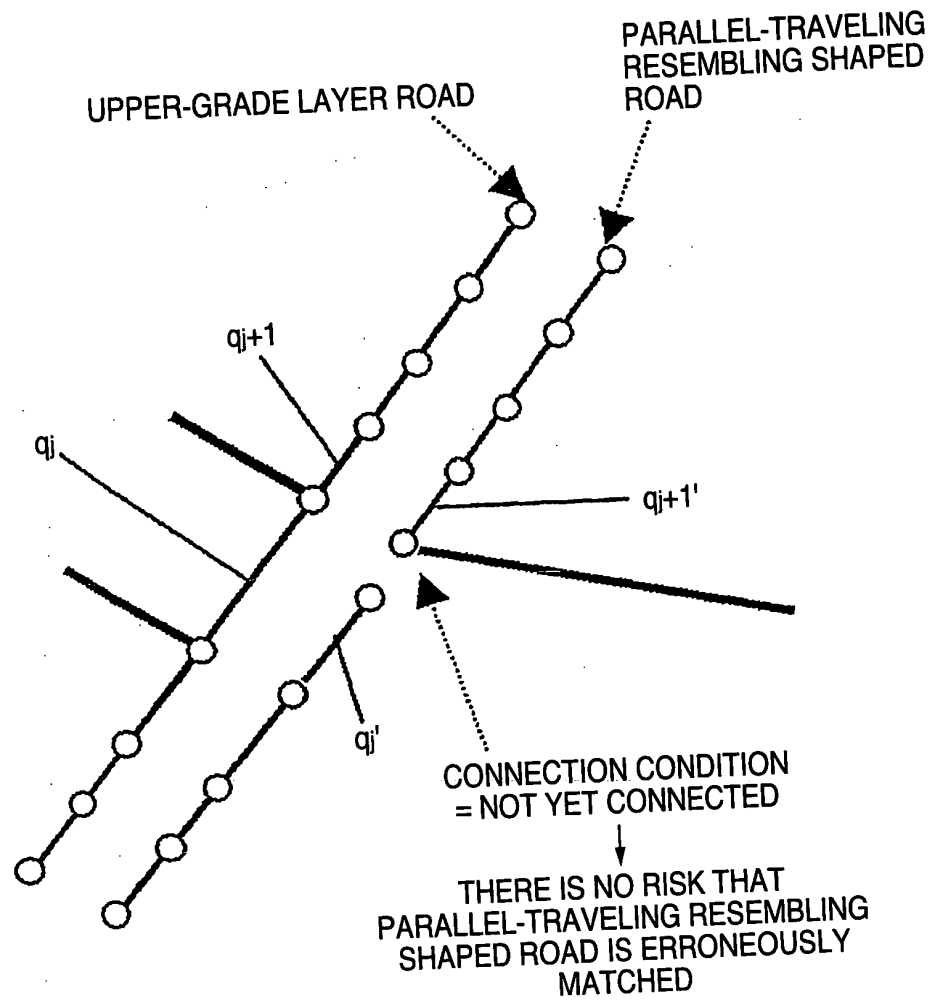


FIG. 12

EXAMPLE OF MAP MATCHING PURPOSE ROAD NETWORK DATA

(a)

| | |
|---|--|
| HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.) | |
| TOTAL NODE NUMBER N | |
| NODE NUMBER 1 | |
| ATTRIBUTE INFORMATION OF NODE 1 | |
| LONGITUDE OF NODE 1 | LATITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #1 | LINK NUMBER #1-1 |
| ⋮ | |
| CONNECTION NODE NUMBER #m | LINK NUMBER #1-m |
| ⋮ | |
| TOTAL LINK NUMBER L | |
| LINK NUMBER 1 | |
| ROAD ATTRIBUTE INFORMATION (ROAD SOAT ETC.) OF LINK 1 | |
| PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK 1 | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK 1 | |
| LONGITUDE OF INTERPOLATION POINT 1-1 | LATITUDE OF INTERPOLATION POINT 1-1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT 1-p | LATITUDE OF INTERPOLATION POINT 1-p |
| ⋮ | |
| LINK NUMBER L | |
| ROAD ATTRIBUTE INFORMATION (ROAD SOAT ETC.) OF LINK L | |
| PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK L | |
| TOTAL STRUCTURAL INTERPOLATION POINT OF LINK L | |
| LONGITUDE OF INTERPOLATION POINT L-1 | LATITUDE OF INTERPOLATION POINT L-1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT L-p | LATITUDE OF INTERPOLATION POINT L-p |

(CONT.)

(b)

PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE INFORMATION
(IN CASE THAT ONE DIRECTION IS INDICATED BY 1 LINK)

| | |
|---|-------------------------|
| DECLINATION ACCUMULATED VALUE OF LINK 1 | |
| DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE OF LINK 1 | |
| TOTAL NUMBER OF PARALLEL-TRAVELING RESEMBLING SHAPES | |
| RESEMBLING SHAPE EVALUATION VALUE | HIERARCHICAL LAYER |
| ROAD ATTRIBUTE | ENTIRE/PARTIAL IDENTIFY |
| DECLINATION ACCUMULATED VALUE | |
| DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE | |
| FLUCTUATION (STANDARD DEVIATION) WITH RESPECT TO LINK 1 | |
| CONNECT/NOT CONNECT AT UP-STREAM SIDED INTERSECTION | |
| DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE (MINIMUM VALUE) OF CONNECTION PORTION | |
| RESEMBLING SHAPE EVALUATION VALUE | HIERARCHICAL LAYER |
| ROAD ATTRIBUTE | ENTIRE/PARTIAL IDENTIFY |
| DECLINATION ACCUMULATED VALUE | |
| DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE | |
| FLUCTUATION (STANDARD DEVIATION) WITH RESPECT TO LINK 1 | |
| CONNECT/NON-CONNECT FLAG TO UP-STREAM SIDED INTERSECTION | |
| DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE (MINIMUM VALUE) OF CONNECTION PORTION | |

(FIG. 12 CONTINUED)

FIG. 13

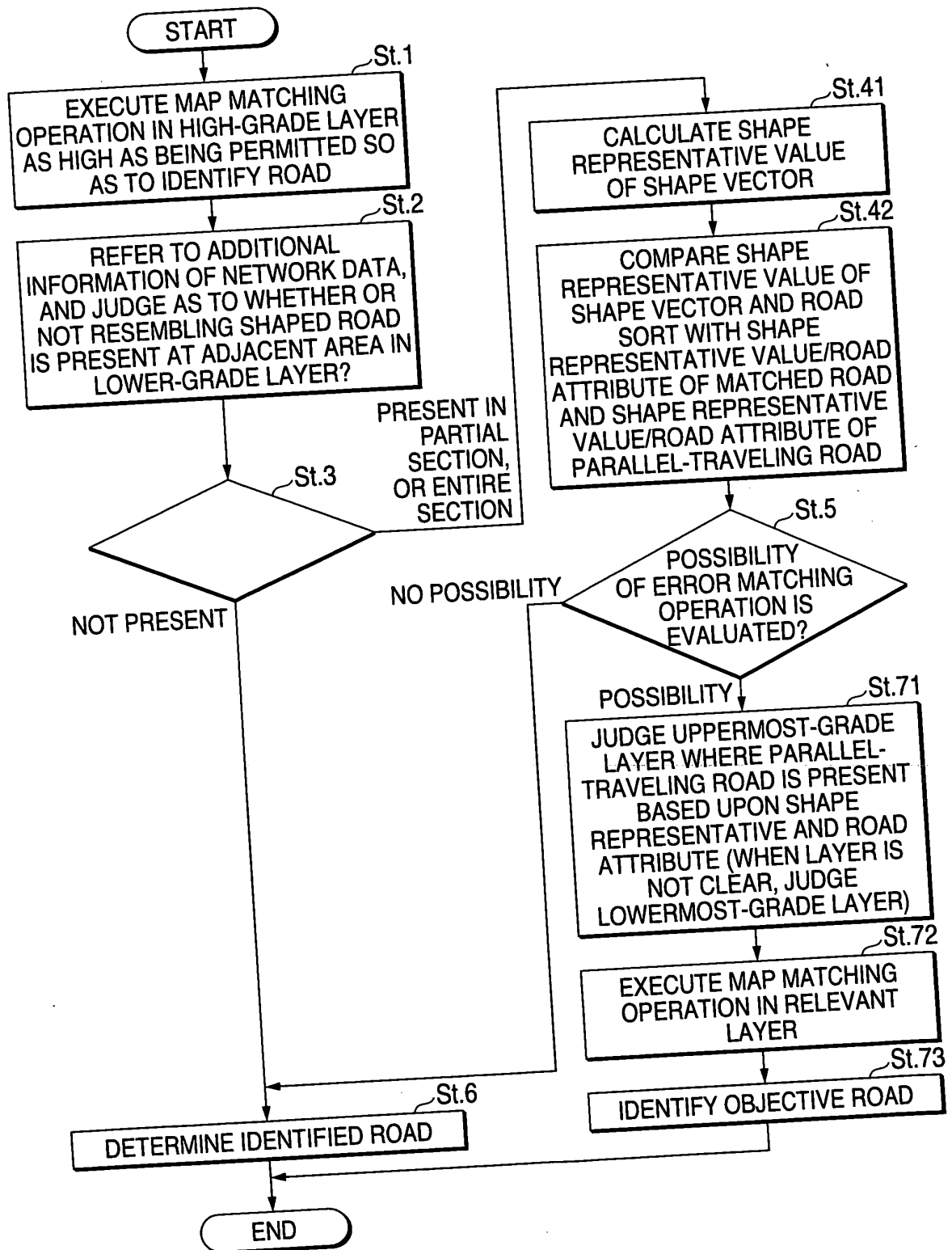


FIG. 14

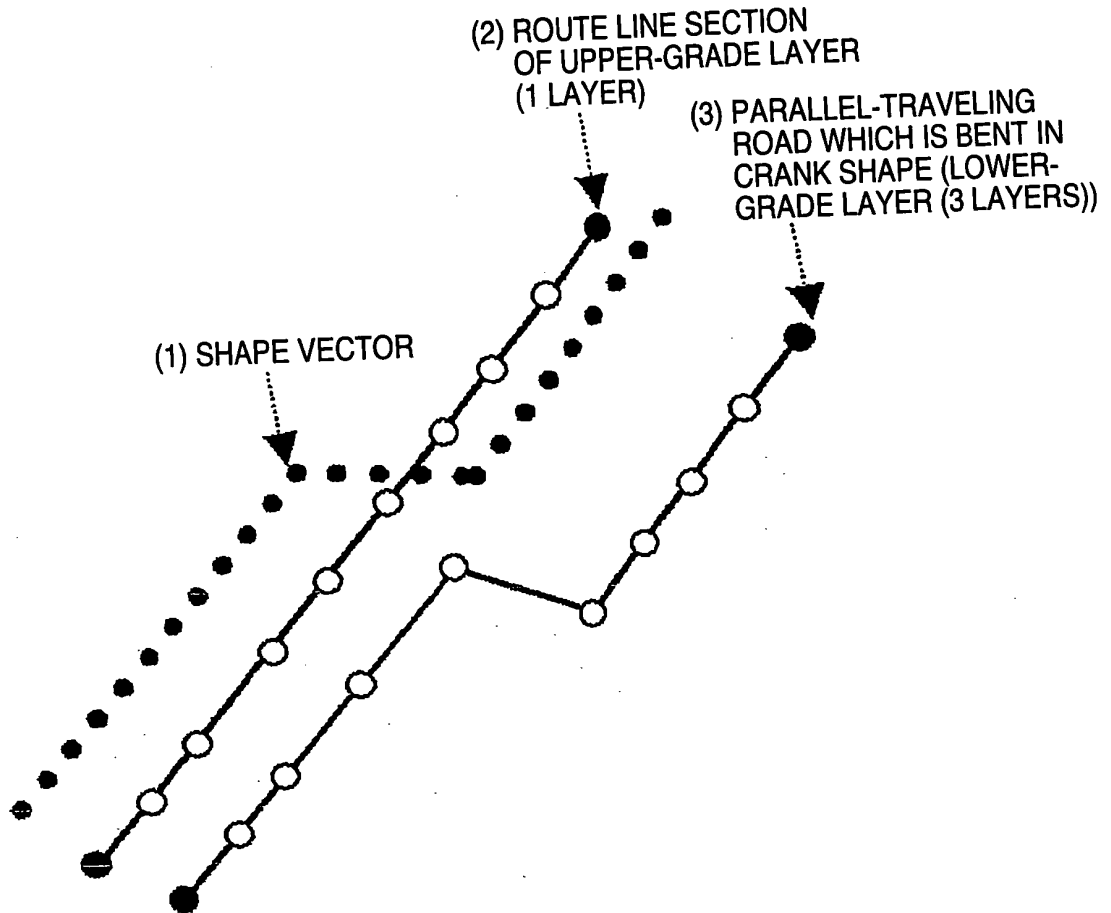
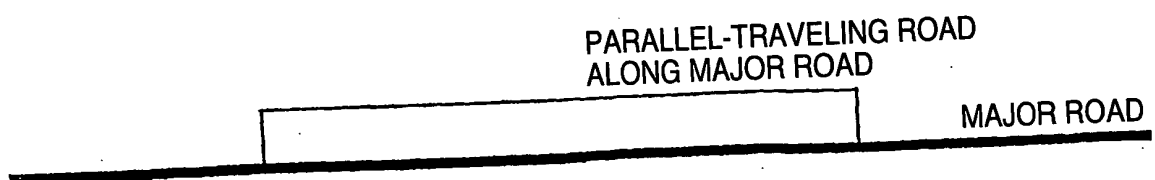


FIG. 15

EXAMPLE IN WHICH PARALLEL-TRAVELING ROAD IS PRESENT IN PARTIAL SECTION



SHAPE VECTOR OF $P_s \rightarrow P_a \rightarrow P_b \rightarrow P_e$
WHICH IS TO BE TRANSMITTED

SINCE ROAD IS NOT PRESENT
BETWEEN $P_b \rightarrow P_e$ IN UPPER-
GRADE LAYER, MISHIT IN
UPPER-GRADE LAYER

MAP MATCHING OPERATION IS
AGAIN NEWLY CARRIED OUT
IN LOWER-GRADE LAYER
(WASTE OF PROCESS TIME)

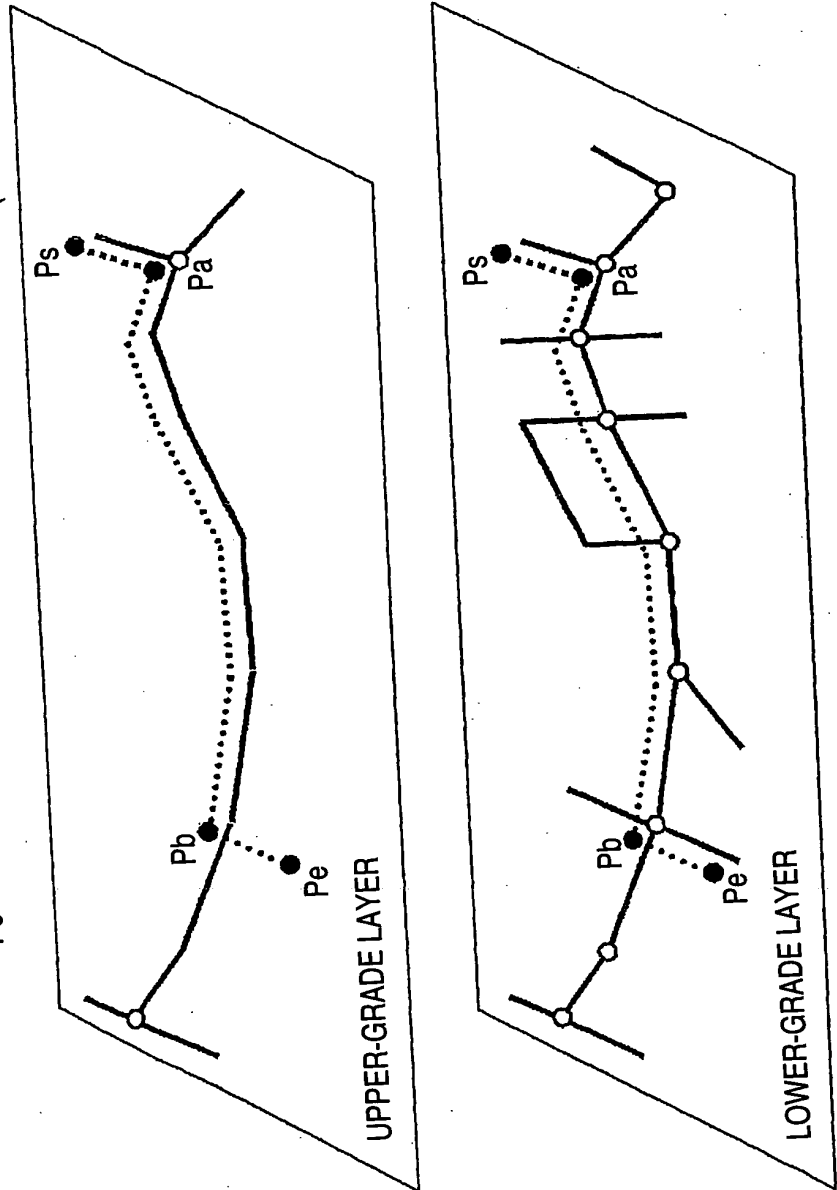


FIG. 16

FIG. 17

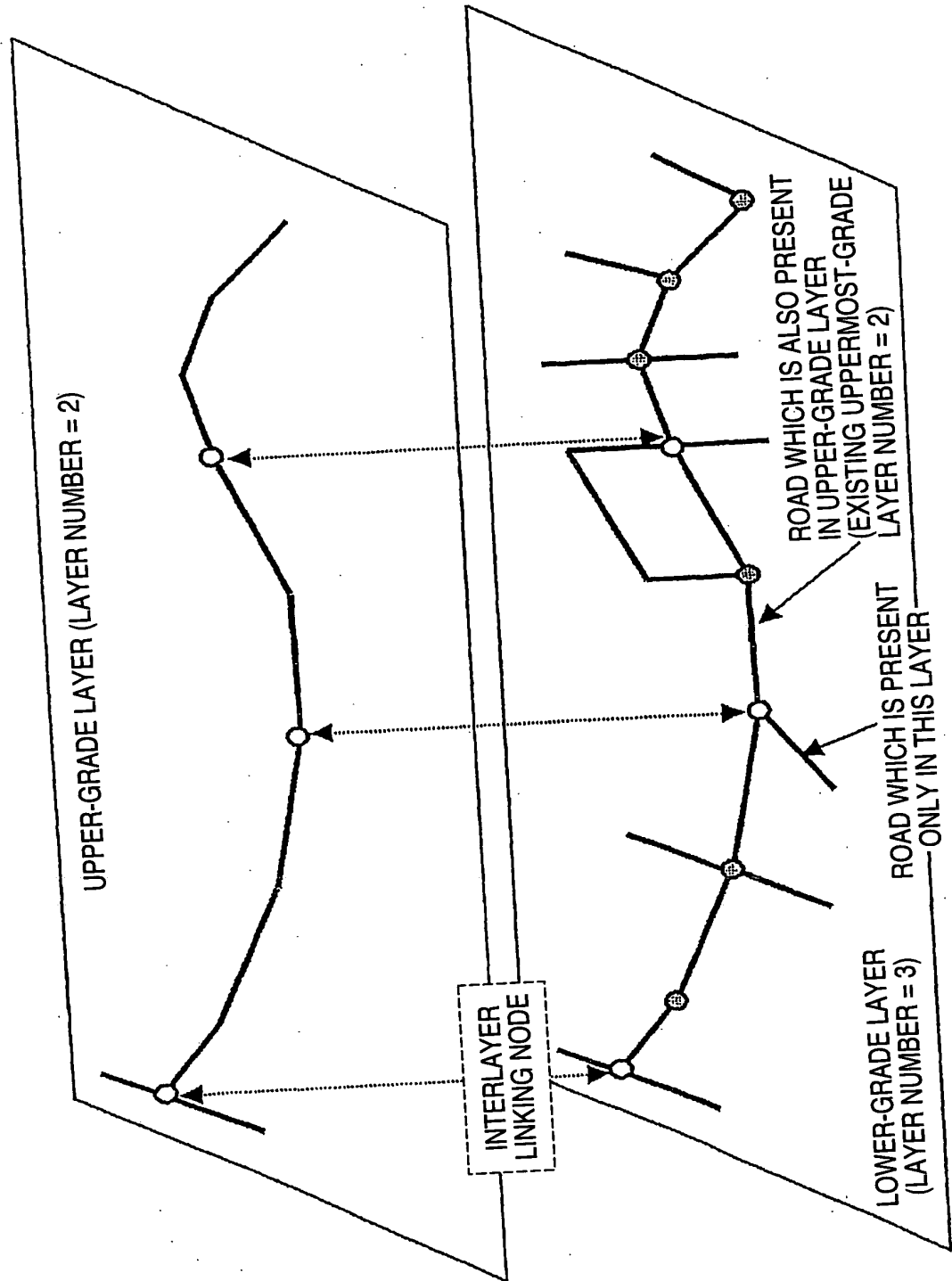


FIG. 18

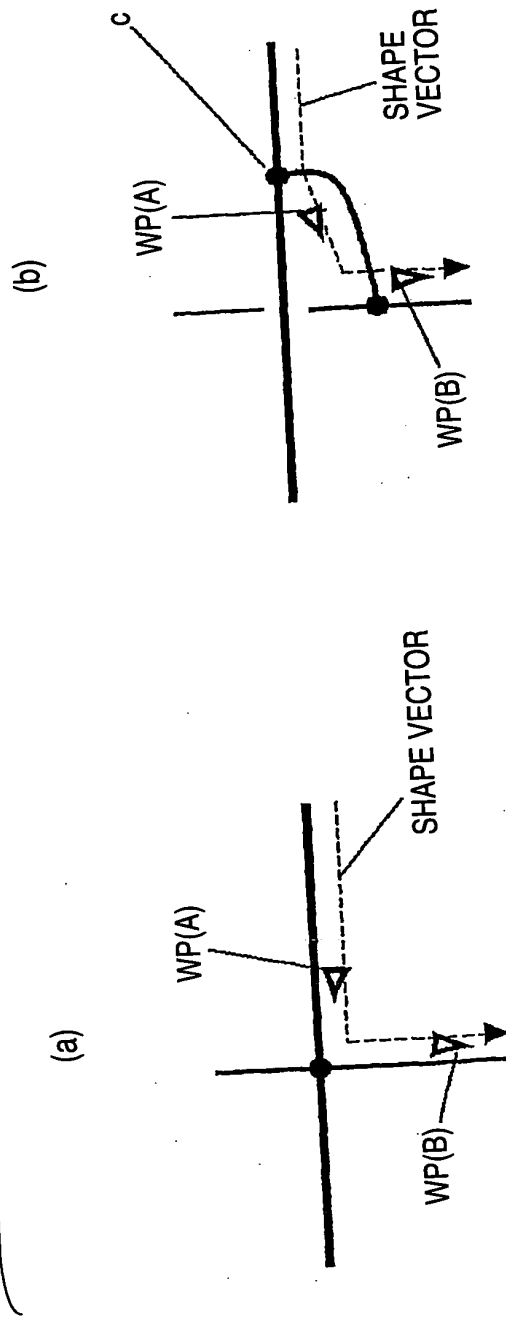


FIG. 19

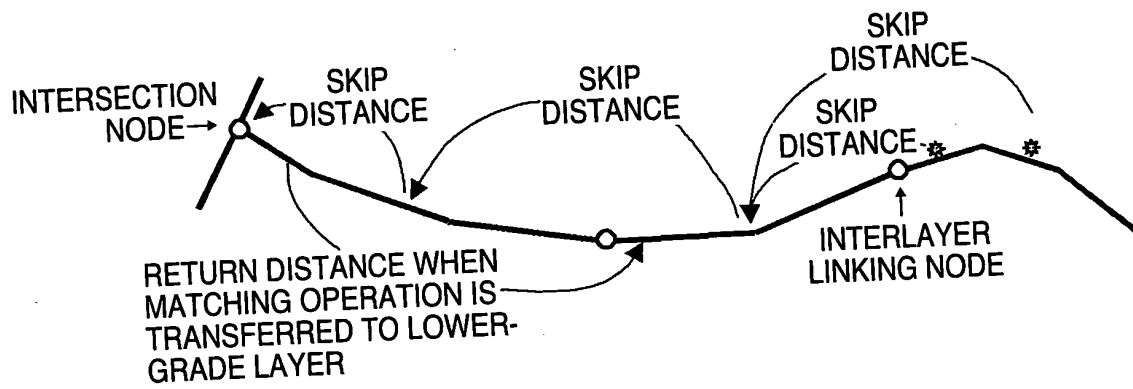


FIG. 20

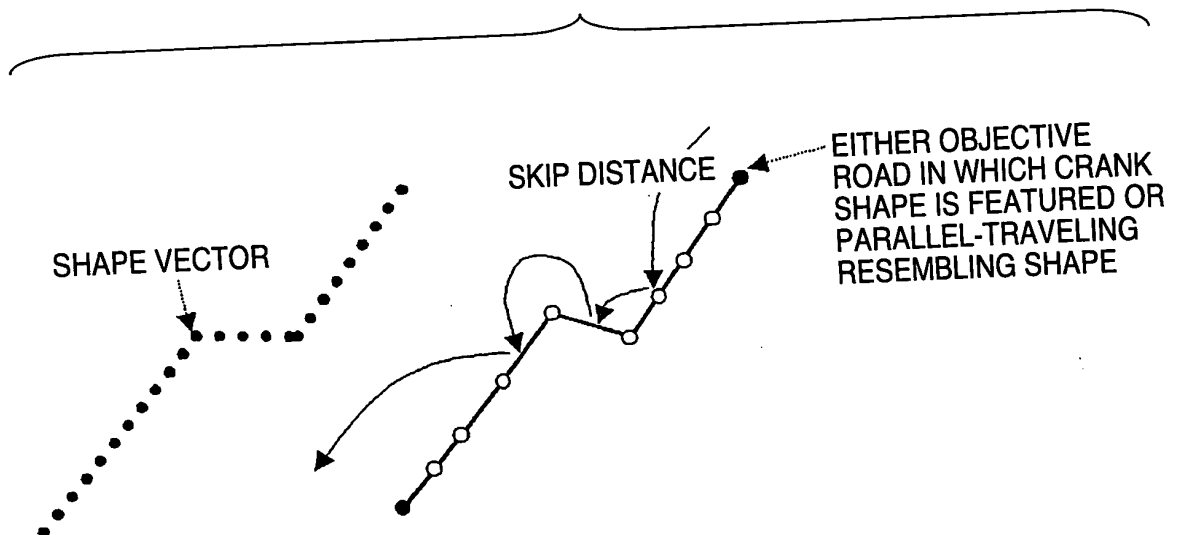


FIG. 21

| | |
|---|--|
| HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.) | |
| TOTAL NODE NUMBER N | |
| NODE NUMBER 1 | |
| ATTRIBUTE INFORMATION OF NODE 1 | |
| LONGITUDE OF NODE 1 | LATITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #1 | LINK NUMBER #1-1 |
| ⋮ | |
| CONNECTION NODE NUMBER #m | LINK NUMBER #1-m |
| ⋮ | |
| TOTAL LINK NUMBER L | |
| LINK NUMBER 1 | |
| ROAD ATTRIBUTE INFORMATION OF LINK 1 | |
| PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK 1 | |
| UPPERMOST-GRADE LAYER NUMBER OF PRESENT ROAD | |
| TOTAL STRUCTURAL INTERPOLATION POINT OF LINK 1 | |
| LONGITUDE OF INTERPOLATION POINT 1-1 | LATITUDE OF INTERPOLATION POINT 1-1 |
| RECOMMENDED SKIP DISTANCE IN LINK BETWEEN 1-1 AND 1-2 (RETURN DISTANCE IN LINK BETWEEN 1-1 AND 1-2 WHEN MAP MATCHING OPERATION IS TRANSFERRED TO LOWER-GRADE LAYER) | |
| LONGITUDE OF INTERPOLATION POINT 1-2 | LATITUDE OF INTERPOLATION POINT 1-2 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT 1-p | LATITUDE OF INTERPOLATION POINT 1-p |
| ⋮ | |

FIG. 22

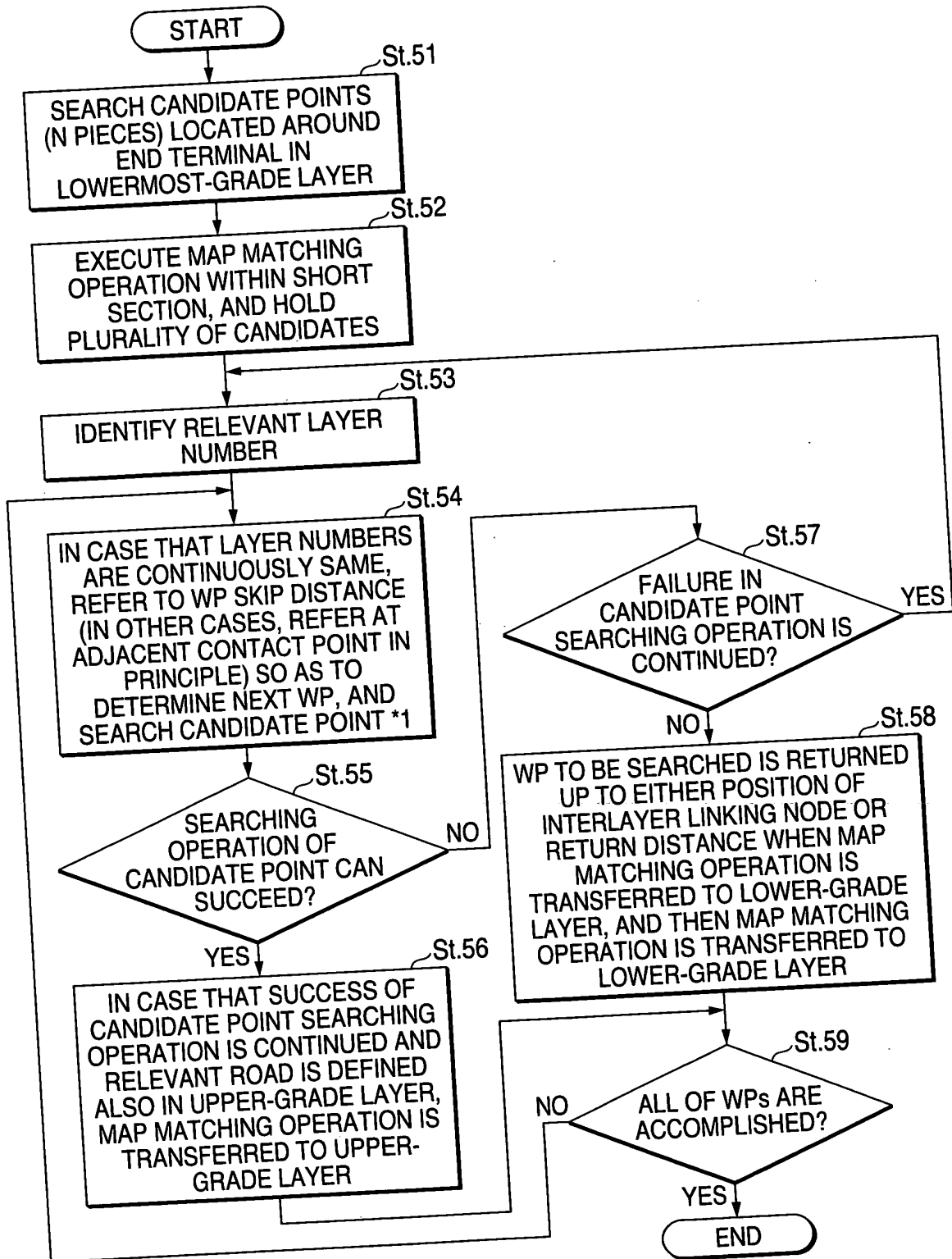


FIG. 23

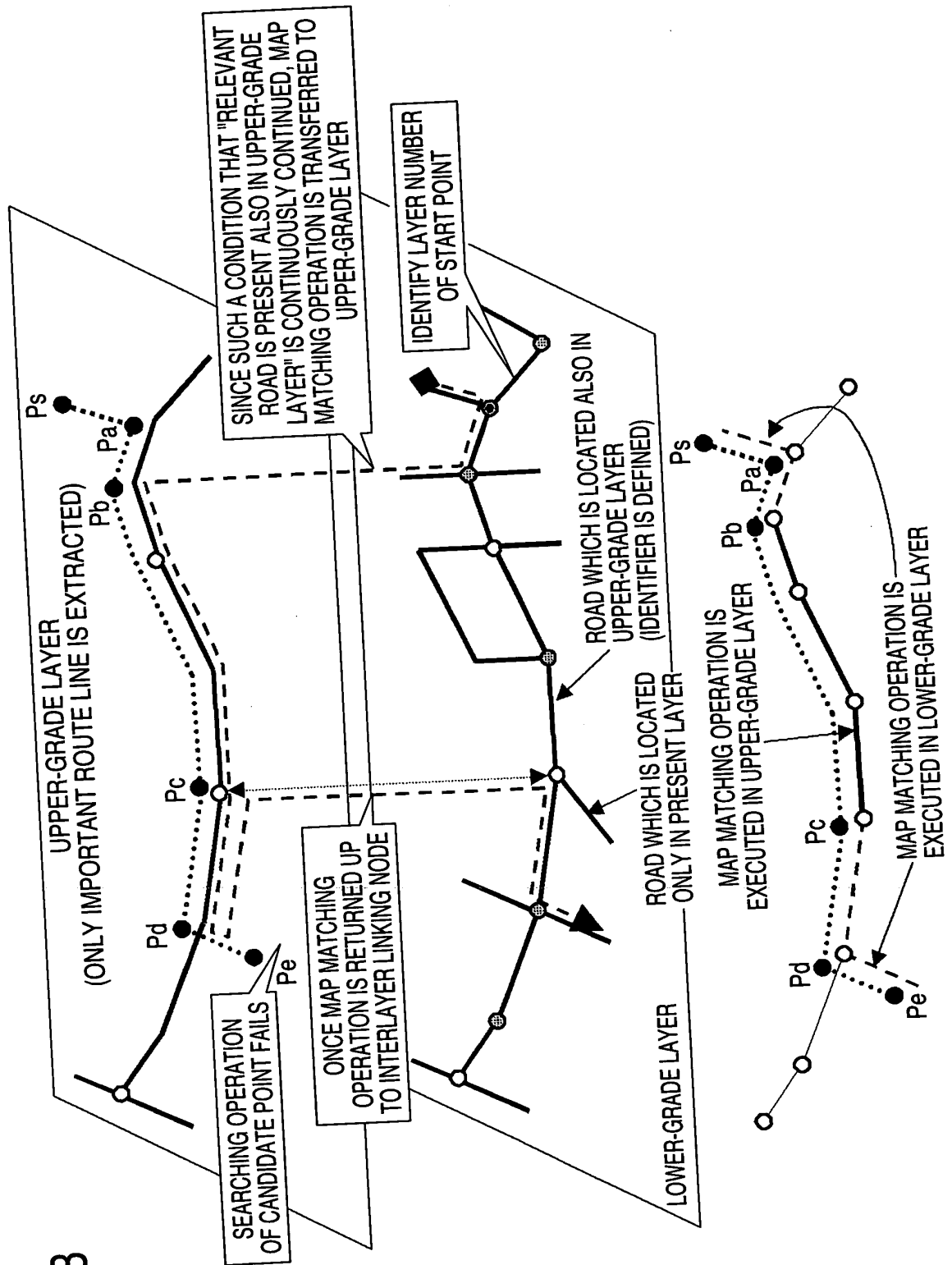


FIG. 24

SHAPE VECTOR DATA STREAM

| |
|--|
| BASE MAP PRECISION INFORMATION OF SHAPE VECTOR |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1 |
| ROAD ATTRIBUTE |
| MAXIMUM DEFORMATION AMOUNT [m] WHEN DEFORMATION IS MADE SO AS TO PREVENT ERRONEOUS MAP MATCHING OPERATION |
| MAXIMUM ALLOWABLE ERROR AMOUNT [m] WHEN NON- REVERSIBLE COMPRESSING OPERATION IS CARRIED OUT |
| TOTAL NODE NUMBER OF SHAPE DATA AFTER COMPRESSING OPERATION |
| NODE NUMBER p1 |
| X-DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| Y-DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| SHAPE DATA WHICH HAS BEEN NONREVERSIBLE-COMPRESSED |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100 |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ |
| ⋮ ⋮ |

FIG. 25

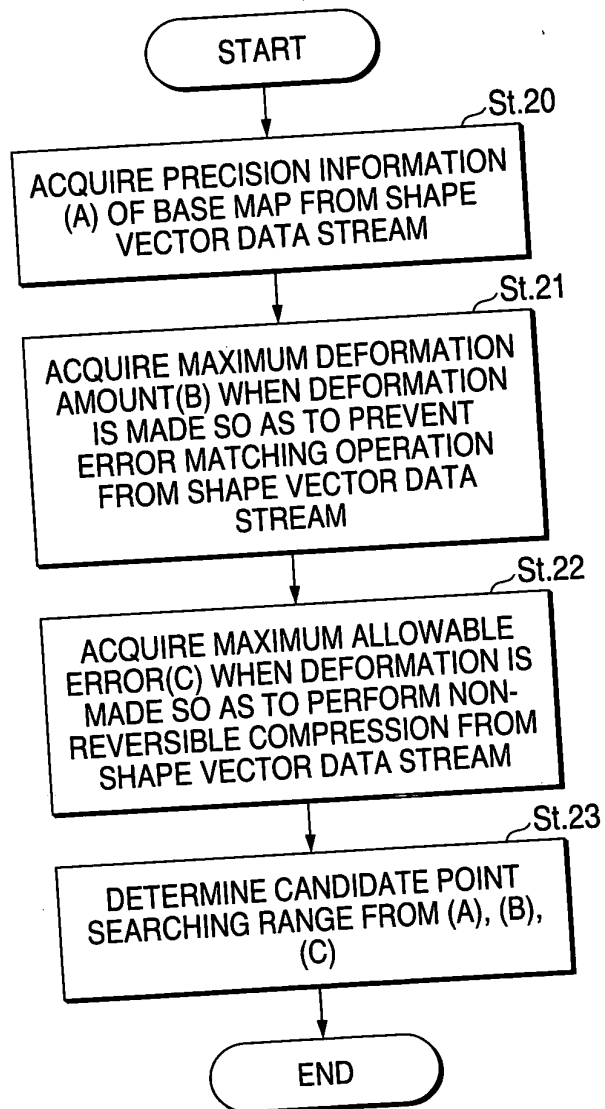


FIG. 26

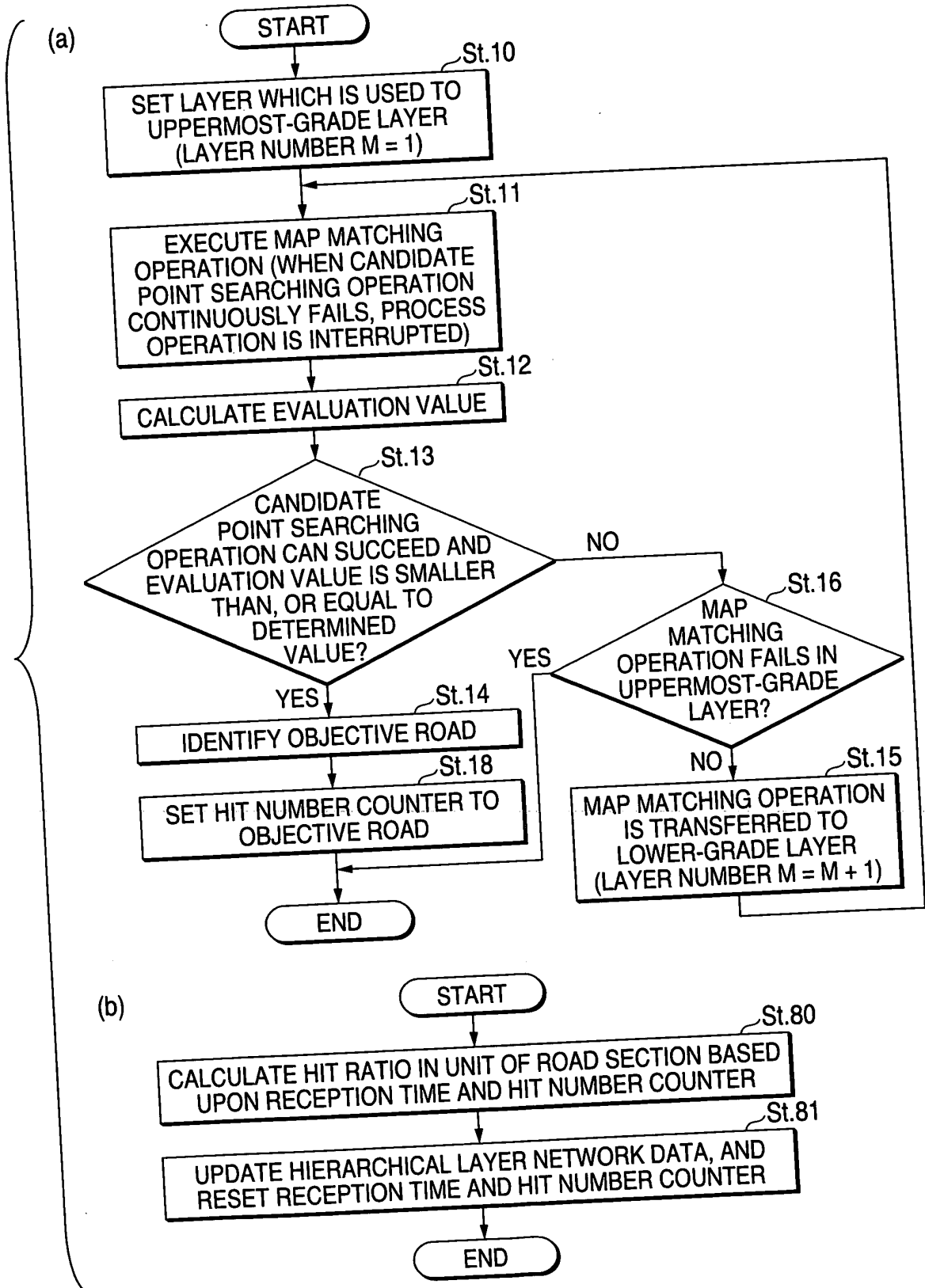


FIG. 27

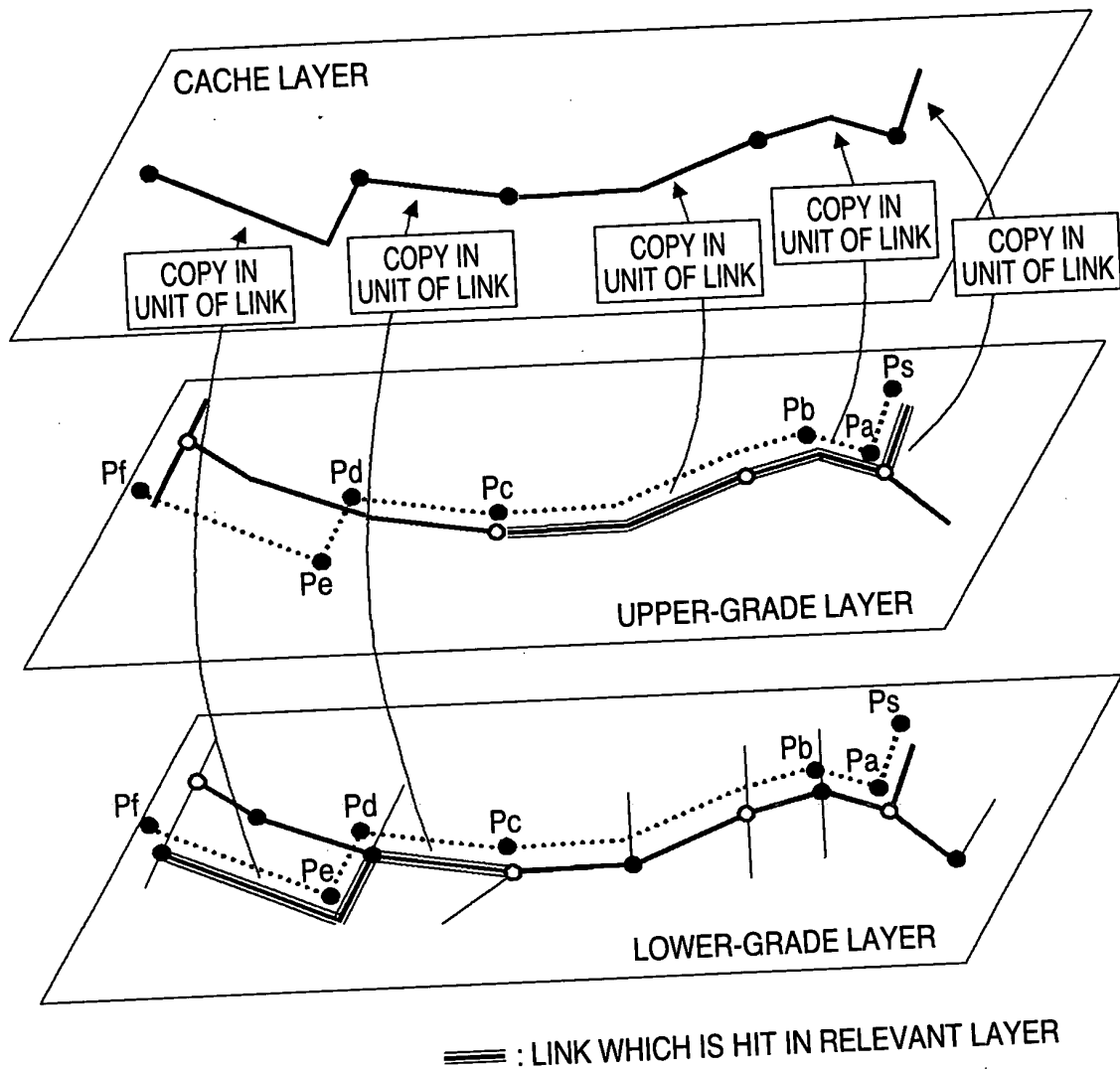


FIG. 28

UPPER-GRADE ROAD NETWORK DATA

(a)

| HEADER INFORMATION (HIERARCHICAL LAYER NUMBER/SECTION DEFINITION ETC.) | |
|---|-------------------------------------|
| TOTAL NODE NUMBER N1 | |
| NODE NUMBER 1 | |
| ATTRIBUTE INFORMATION OF NODE 1 | |
| LONGITUDE OF NODE 1 | LATITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #J1 | LINK NUMBER #J1-1 |
| | |
| CONNECTION NODE NUMBER #Jm | LINK NUMBER #J1-m |
| | |
| | |
| NODE NUMBER S | |
| NODE ATTRIBUTE INFORMATION OF NODE S | |
| LONGITUDE OF NODE S | LATITUDE OF NODE S |
| TOTAL NUMBER OF NODES CONNECTED TO NODE S (=2) | |
| CONNECTION NODE NUMBER #J1 | LINK NUMBER #SJ1 |
| CONNECTION NODE NUMBER #J2 | LINK NUMBER #SJ2 |
| | |
| | |
| TOTAL LINK NUMBER L1 | |
| LINK NUMBER A | |
| ROAD ATTRIBUTE INFORMATION OF LINK A | |
| PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK A | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK A | |
| LONGITUDE OF INTERPOLATION POINT A-1 | LATITUDE OF INTERPOLATION POINT A-1 |
| | |
| LONGITUDE OF INTERPOLATION POINT A-p | LATITUDE OF INTERPOLATION POINT A-p |
| | |
| | |
| LINK NUMBER SJ1 | |
| ROAD ATTRIBUTE INFORMATION OF LINK SJ1 | |
| PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK SJ1 | |
| TOTAL STRUCTURAL INTERPOLATION POINT OF LINK SJ1 | |
| LONGITUDE OF INTERPOLATION POINT 1 | LATITUDE OF INTERPOLATION POINT 1 |
| | |
| LONGITUDE OF INTERPOLATION POINT p | LATITUDE OF INTERPOLATION POINT p |
| | |
| | |

(CONT.)

LOWER-GRADE ROAD NETWORK DATA

(b)

| HEADER INFORMATION (HIERARCHICAL LAYER NUMBER/SECTION DEFINITION ETC.) | |
|---|-------------------------------------|
| TOTAL NODE NUMBER N1 | |
| NODE NUMBER 1 | |
| ATTRIBUTE INFORMATION OF NODE 1 | |
| LONGITUDE OF NODE 1 | LATITUDE OF NODE 1 |
| TOTAL NUMBER OF NODES CONNECTED TO NODE 1 | |
| CONNECTION NODE NUMBER #1 | LINK NUMBER #1-1 |
| ⋮ | |
| CONNECTION NODE NUMBER #m | LINK NUMBER #1-m |
| ⋮ | |
| NODE NUMBER S | |
| NODE ATTRIBUTE INFORMATION OF NODE S | |
| LONGITUDE OF NODE S | LATITUDE OF NODE S |
| TOTAL NUMBER OF NODES CONNECTED TO NODE S (=3) | |
| CONNECTION NODE NUMBER #K1 | LINK NUMBER #SK1 |
| CONNECTION NODE NUMBER #K2 | LINK NUMBER #SK2 |
| CONNECTION NODE NUMBER #K3 | LINK NUMBER #SK3 |
| ⋮ | |
| TOTAL LINK NUMBER L2 | |
| LINK NUMBER B | |
| ROAD ATTRIBUTE INFORMATION OF LINK B | |
| PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK B | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK B | |
| LONGITUDE OF INTERPOLATION POINT B-1 | LATITUDE OF INTERPOLATION POINT B-1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT B-p | LATITUDE OF INTERPOLATION POINT B-p |
| ⋮ | |
| LINK NUMBER SK2 | |
| ROAD ATTRIBUTE INFORMATION OF LINK SK2 | |
| PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK SK2 | |
| TOTAL STRUCTURAL INTERPOLATION POINT OF LINK SK2 | |
| LONGITUDE OF INTERPOLATION POINT 1 | LATITUDE OF INTERPOLATION POINT 1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT p' | LATITUDE OF INTERPOLATION POINT p' |
| ⋮ | |

(FIG. 28 CONTINUED)

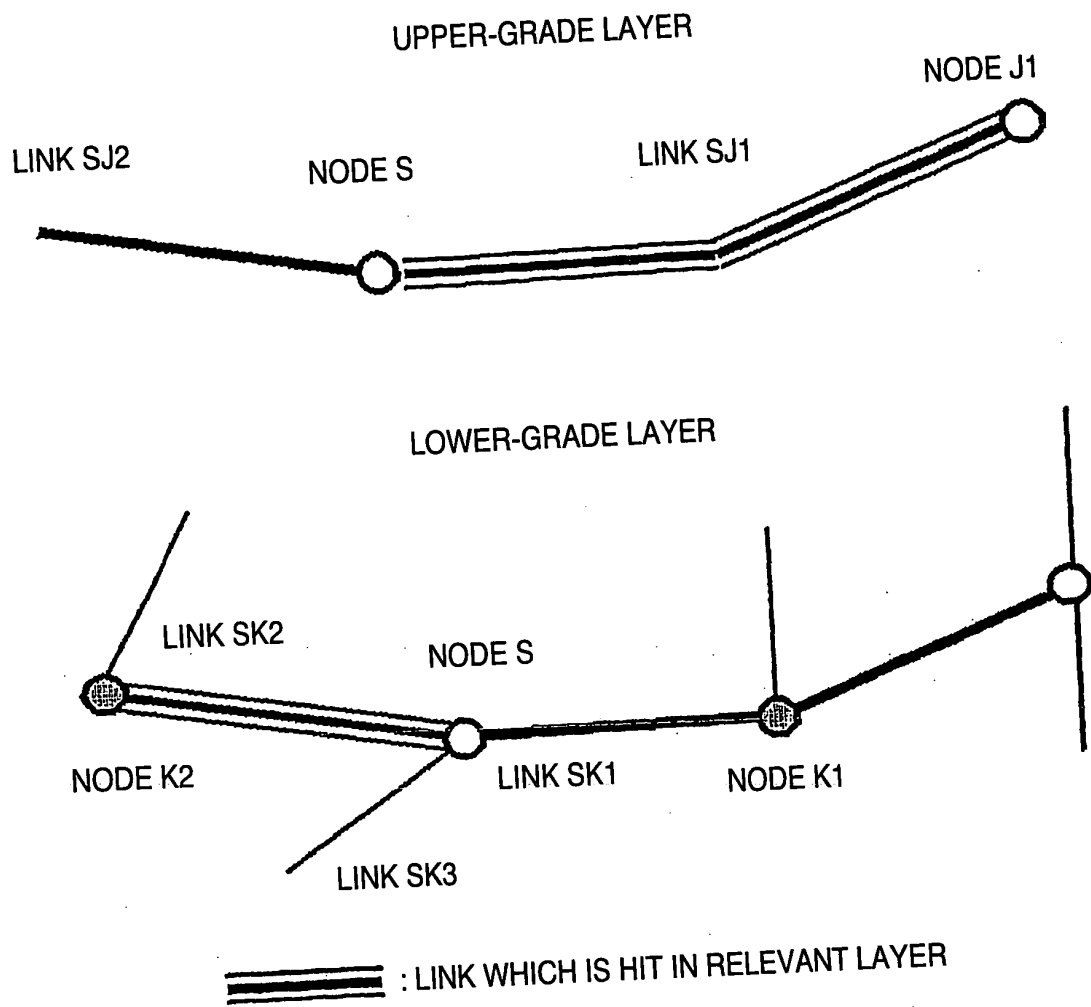
(CONT.)

(c) CACHE LAYER ROAD NETWORK DATA (HATCHED PORTIONS OF UPPER-GRADE/LOWER-GRADE LAYER DATA ARE COPIED, AND EVERY TIME TOTAL NUMBER OF NODES IS CALCULATED, CACHE LAYER ROAD NETWORK DATA IS PRODUCED)

| HEADER INFORMATION (HIERARCHICAL LAYER NUMBER/SECTION DEFINITION ETC.) | |
|---|---------------------------------------|
| TOTAL NODE NUMBER N (SEQUENTIALLY ADD EVERY COPY) | |
| ⋮ | |
| NODE NUMBER S | |
| ATTRIBUTE INFORMATION OF NODE S | |
| LONGITUDE OF NODE S | LATITUDE OF NODE S |
| TOTAL NUMBER OF NODES CONNECTED TO NODE S (=2) | |
| CONNECTION NODE NUMBER #J1 | LINK NUMBER #SJ1 |
| CONNECTION NODE NUMBER #K2 | LINK NUMBER #SK2 |
| ⋮ | |
| TOTAL LINK NUMBER L (SEQUENTIALLY ADD EVERY COPY) | |
| ⋮ | |
| LINK NUMBER SJ1 | |
| ROAD ATTRIBUTE INFORMATION OF LINK SJ1 | |
| PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK SJ1 | |
| TOTAL STRUCTURAL INTERPOLATION POINT OF LINK SJ1 | |
| LONGITUDE OF INTERPOLATION POINT 1 | LATITUDE OF INTERPOLATION POINT 1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT p | LATITUDE OF INTERPOLATION POINT p |
| ⋮ | |
| LINK NUMBER SK2 | |
| ROAD ATTRIBUTE INFORMATION OF LINK SK2 | |
| PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK SK2 | |
| TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SK2 | |
| LONGITUDE OF INTERPOLATION POINT 1 | LATITUDE OF INTERPOLATION POINT 1 |
| ⋮ | |
| LONGITUDE OF INTERPOLATION POINT p' | LATITUDE OF INTERPOLATION POINT p' |
| ⋮ | |

(FIG. 28(b) CONTINUED)

FIG. 29



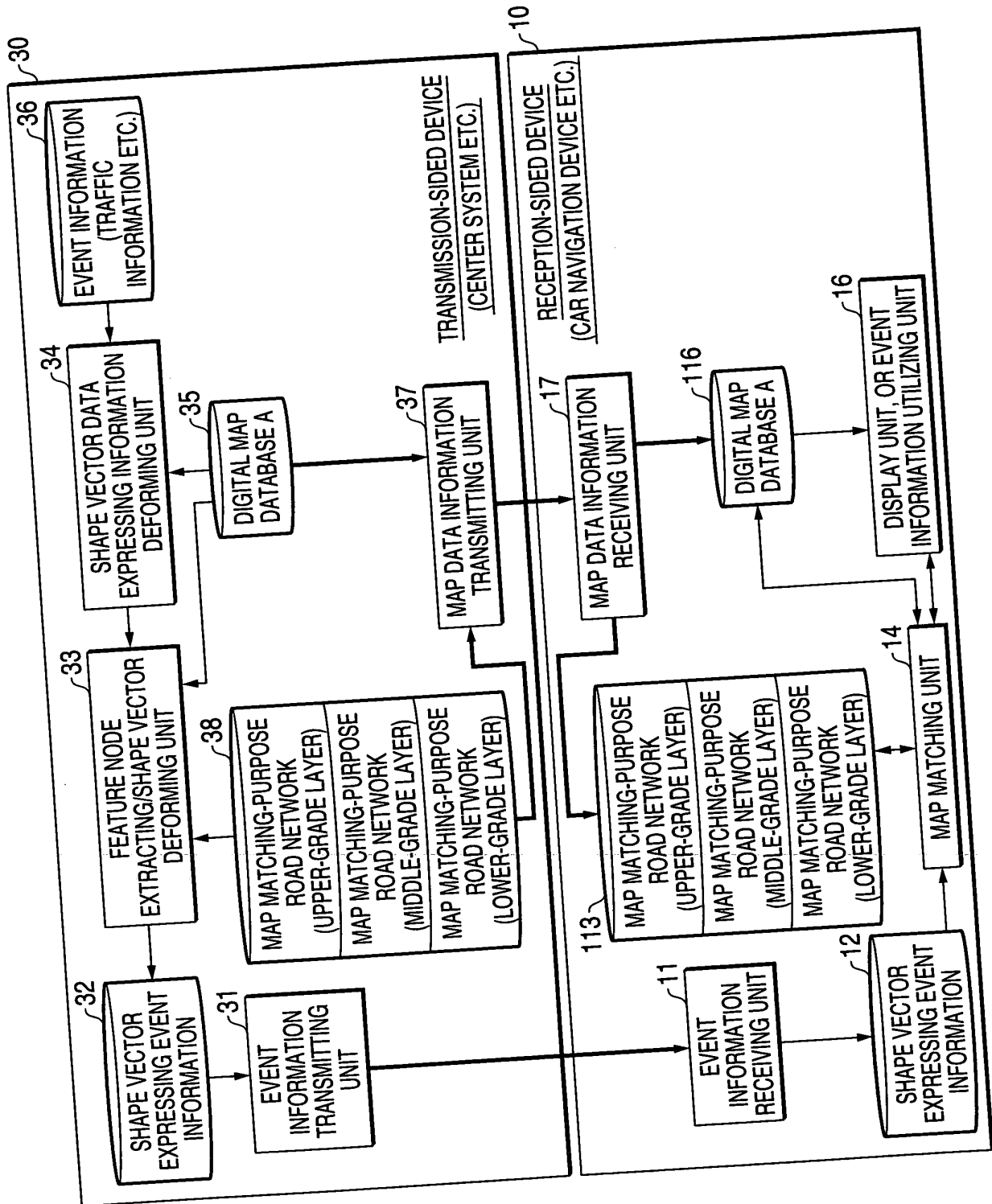


FIG. 30

FIG. 31

EXAMPLE 1, SHAPE VECTOR DATA STREAM (HIERARCHICAL LAYER JUDGING INFORMATION IS ADDED IN UNIT OF SHAPE VECTOR)

(a)

| |
|---|
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1 |
| HIERARCHICAL LAYER NUMBER |
| ROAD ATTRIBUTE (ROAD SORT ETC.) |
| TOTAL NODE NUMBER |
| NODE NUMBER p1 |
| X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| ABSOLUTE AZIMUTH OF NODE 1 |
| ⋮ |
| NODE NUMBER pN |
| RELATIVE COORDINATE (x _n) OF NODE N |
| RELATIVE COORDINATE (y _n) OF NODE N |
| RELATIVE AZIMUTH OF NODE N |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100 |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ |
| ⋮ ⋮ |

(CONT.)

(b) EXAMPLE 2, SHAPE VECTOR DATA STREAM (HIERARCHICAL LAYER JUDGING INFORMATION IS ADDED IN UNIT OF NODE)

| | |
|---|--------------------------|
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1 | |
| TOTAL NODE NUMBER | |
| NODE NUMBER p1 | |
| HIERARCHICAL LAYER NUMBER OF NODE 1 | ROAD ATTRIBUTE OF NODE 1 |
| X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 | |
| Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 | |
| ABSOLUTE AZIMUTH OF NODE 1 | |
| ⋮ | |
| NODE NUMBER pN | |
| HIERARCHICAL LAYER NUMBER OF NODE N | ROAD ATTRIBUTE OF NODE N |
| RELATIVE COORDINATE (x _n) OF NODE N | |
| RELATIVE COORDINATE (y _n) OF NODE N | |
| RELATIVE AZIMUTH OF NODE N | |
| ⋮ | |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100 | |
| ⋮ | |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ | |
| ⋮ | |

(FIG. 31 CONTINUED)

FIG. 32

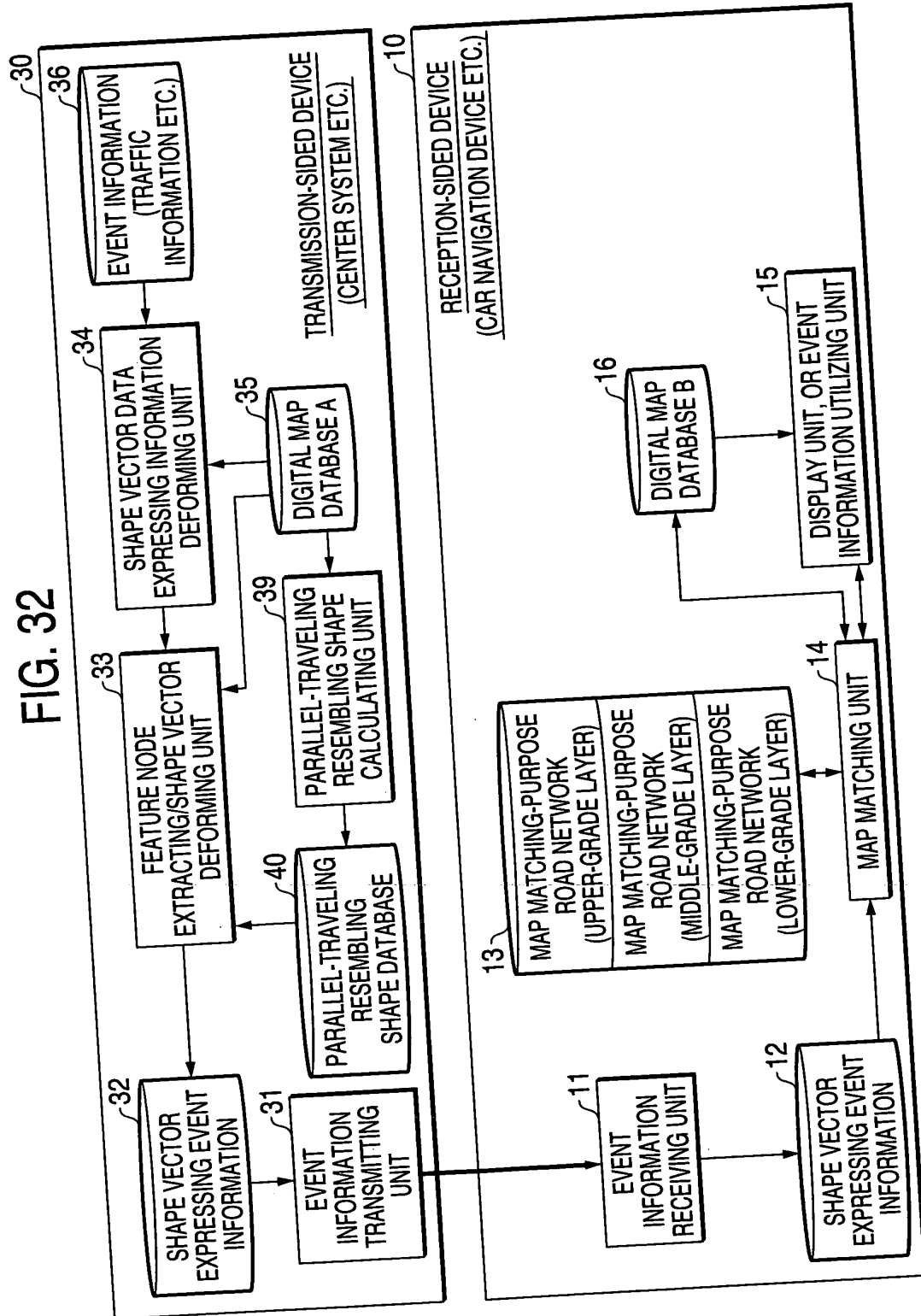


FIG. 33

< PARALLEL-TRAVELING RESEMBLING
SHAPE EXTRACTING PROCESS OPERATION >

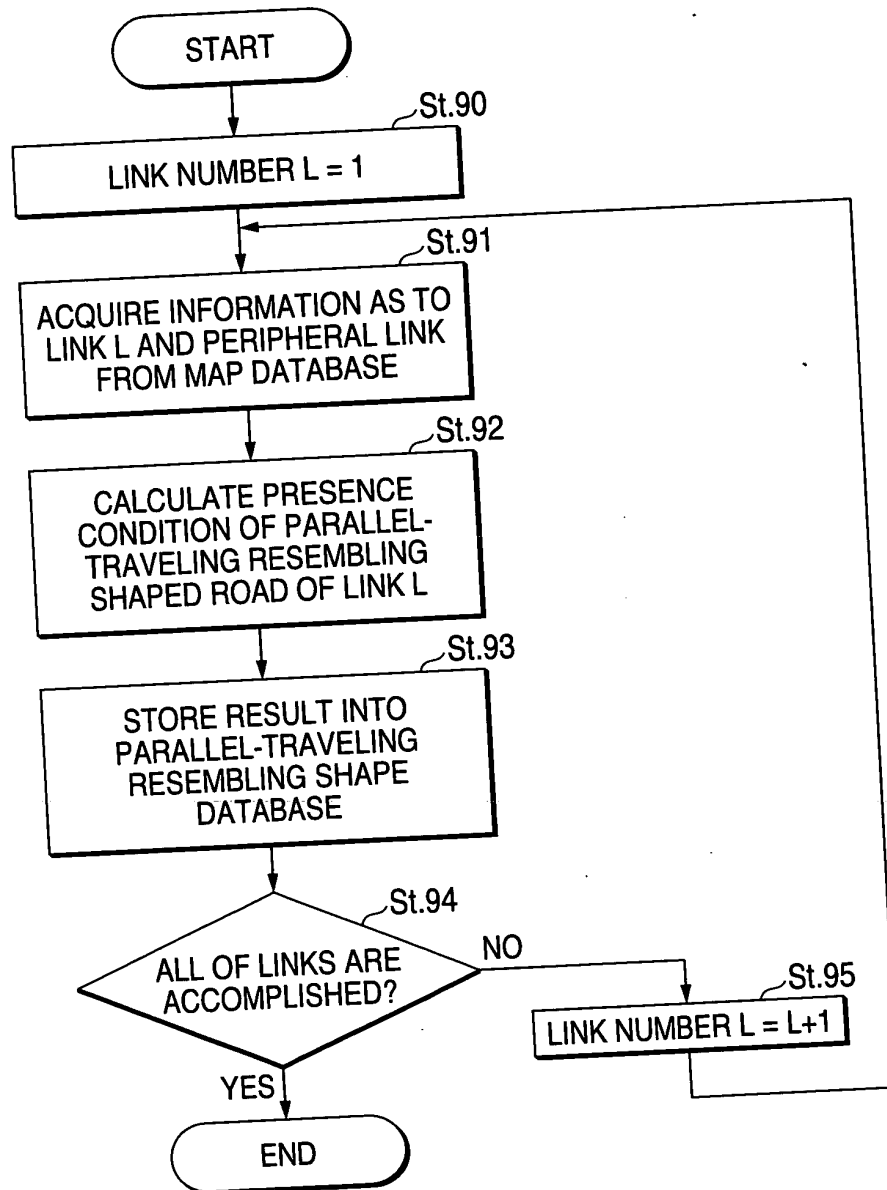


FIG. 34

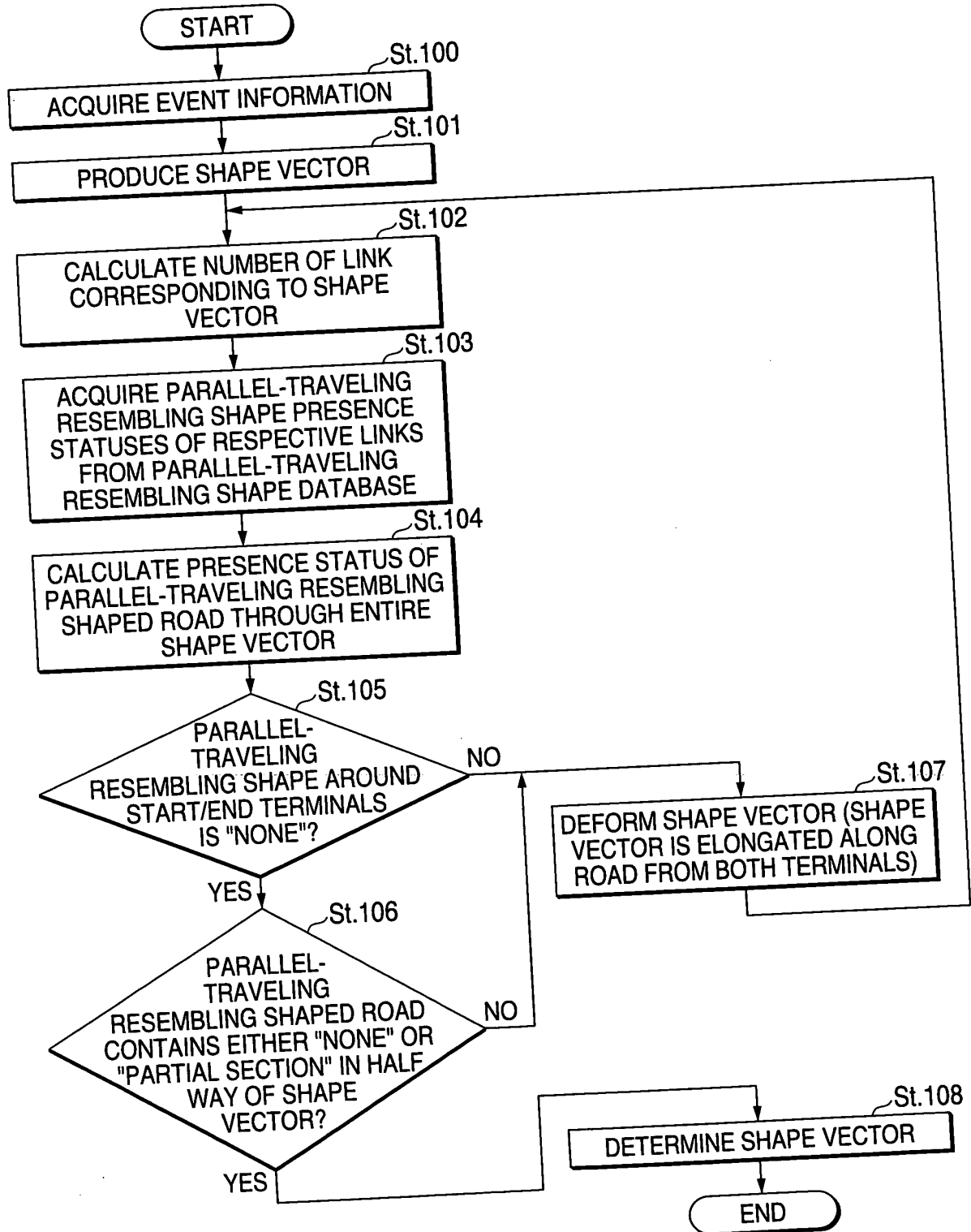
< SHAPE VECTOR PRODUCING
PROCESS OPERATION >

FIG. 35

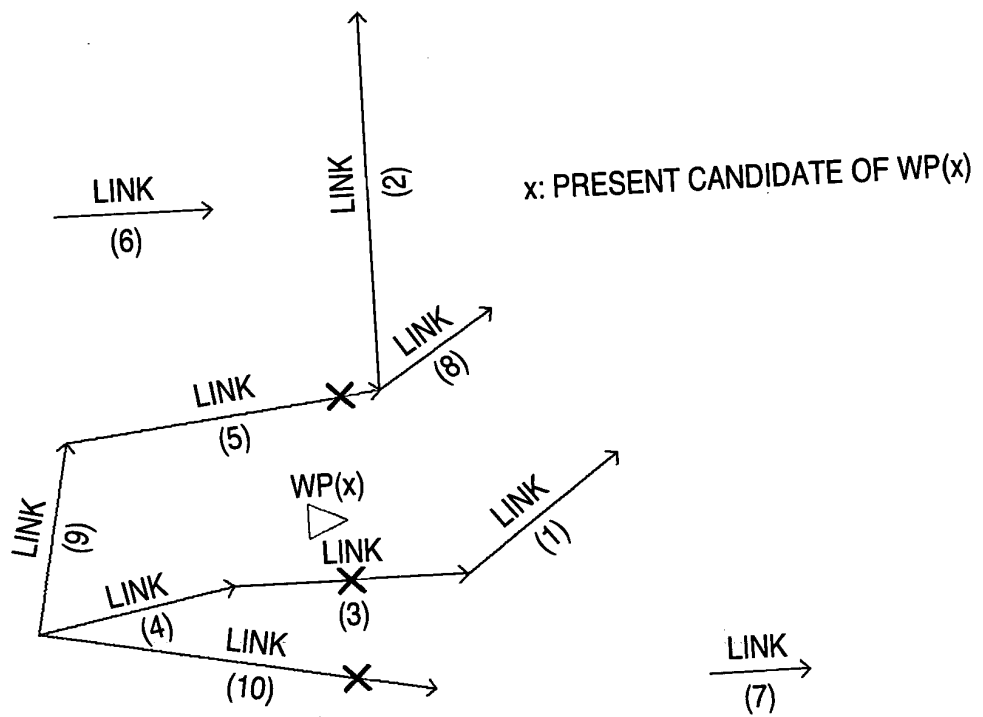


FIG. 36

(a) SHAPE VECTOR DATA STREAM

| |
|---|
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1 |
| SORT OF VECTOR DATA (= ROAD) |
| TOTAL NODE NUMBER |
| NODE NUMBER p1 |
| X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| ABSOLUTE AZIMUTH OF NODE 1 |
| ⋮ |
| NODE NUMBER pN |
| RELATIVE COORDINATE (x _n) OF NODE N |
| RELATIVE COORDINATE (y _n) OF NODE N |
| RELATIVE AZIMUTH OF NODE N |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100 |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ |
| ⋮ ⋮ |

(CONT.)

(b) TRAVEL TIME INFORMATION

| | |
|--|---|
| TOTAL NUMBER V OF TRAVEL TIME PROVIDING SECTIONS | |
| PROVIDED TRAVEL TIME SERIAL NUMBER = 1 | |
| REFERENCE SHAPE VECTOR STREAM NUMBER = 8 | |
| DIRECTION IDENTIFICATION FLAG (FORWARD DIRECTION/REVERSE DIRECTION) | |
| REFERENCE NODE Pa OF STARTING TERMINAL SIDE | RELATIVE DISTANCE La OF STRATTON TERMINAL SIDE |
| REFERENCE NODE Pb OF END TERMINAL SIDE | RELATIVE DISTANCE Lb OF STRATTON TERMINAL SIDE |
| TRAVEL TIME T1 BETWEEN STARTING TERMINAL AND END TERMINAL | |
| : : | |
| PROVIDED TRAVEL TIME SERIAL NUMBER V | |
| REFERENCE SHAPE VECTOR STREAM NUMBER = 124 | |
| DIRECTION IDENTIFICATION FLAG (FORWARD DIRECTION/REVERSE DIRECTION) | |
| REFERENCE NODE Pc OF STARTING TERMINAL SIDE | RELATIVE DISTANCE Lc OF STRATTON TERMINAL SIDE |
| REFERENCE NODE Pd OF END TERMINAL SIDE | RELATIVE DISTANCE Ld OF STRATTON END SIDE |
| TRAVEL TIME Tv BETWEEN STARTING TERMINAL AND END TERMINAL = Tv | |

(FIG. 36 CONTINUED)

FIG. 37

(a)

SHAPE VECTOR DATA STREAM INFORMATION (CODED/COMPRESSED DATA)

| | |
|---|---|
| HEADER INFORMATION | |
| TOTAL SHAPE VECTOR NUMBER N | |
| SHAPE VECTOR DATA IDENTIFICATION NUMBER =1 | |
| CODE TABLE IDENTIFICATION CODE | |
| PRECISION INFORMATION OF SHAPE ACQUISITION SOURCE MAP DATA | |
| ONE-DIRECTION TRAVEL DIRECTION (FORWARD/REVERSE/NON-DIRECTION) | |
| STARTING TERMINAL NODE NUMBER ps | |
| X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE ps | |
| Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE ps | |
| ABSOLUTE AZIMUTH OF NODE ps | |
| ps POSITION ERROR(m) | ps AZIMUTH ERROR (DEGREE) |
| MAXIMUM POSITIONAL ERROR(m) OF CODED SHAPE DATA | MAXIMUM AZIMUTH ERROR (DEGREE) OF CODED SHAPE DATA |
| CODED SHAPE DATA, IT SHOULD BE NOTED THAT CODED SHAPE DATA ALSO CONTAINS FOLLOWING INFORMATION: REFERENCE CODE SETTING CODE, SECTION LENGTH CHANGING CODE, EOD CODE | |
| END TERMINAL NODE NUMBER pe | |
| X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE pe | |
| Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE pe | |
| ABSOLUTE AZIMUTH OF NODE pe | |
| pe POSITION ERROR (m) | pe AZIMUTH ERROR (DEGREE) |
| ⋮ | |
| SHAPE VECTOR DATA IDENTIFICATION NUMBER = M | |
| ⋮ | |

(CONT.)

(b)

| TRAFFIC INFORMATION | |
|--|--|
| HEADER INFORMATION | |
| TOTAL NUMBER V OF TRAFFIC INFORMATION PROVIDING SECTIONS | |
| SERIAL NUMBER 1 OF TRAFFIC INFORMATION PROVIDING SECTION | |
| REFERENCE SHAPE VECTOR STREAM NUMBER = N | |
| DIRECTION IDENTIFICATION FLAG (FORWARD DIRECTION/REVERE DIRECTION) | |
| START TERMINAL-SIDED REFERENCE NODE p_a | END TERMINAL-SIDED REFERENCE NODE p_b |
| QUANTIZING SECTION LENGTH IDENTIFICATION CODE OF DISTANCE DIRECTION | |
| TRAFFIC INFORMATION QUANTIZING TABLE IDENTIFICATION CODE | |
| CODED TABLE IDENTIFICATION CODE | |
| TOTAL NUMBER OF QUANTIZED UNIT SECTIONS *2 | |
| TRAFFIC INFORMATION (INITIAL VALUE) OF START TERMINAL | |
| TRAFFIC INFORMATION CODED BY DIFFERENCE VALUE WITH RESPECT TO PREDICTED STATISTICAL VALUE, IT SHOULD BE NOTED THAT TRAFFIC INFORMATION CONTAINS ALSO FOLLOWING INFORMATION: SECTION LENGTH CHANGING CODE AND CHANGED SECTION LENGTH, TRAFFIC INFORMATION QUANTIZED TABLE CHANGING CODE AND CHANGED TABLE NUMBER, REFERENCE NODE CORRESPONDING POINT IDENTIFICATION CODE AND CORRESPONDING REFERENCE NODE NUMBER + OFFSET DISTANCE | |
| : | |
| TRAFFIC INFORMATION PROVIDING SECTION SERIAL NUMBER = W | |
| : | |

(FIG. 37 CONTINUED)

FIG. 38

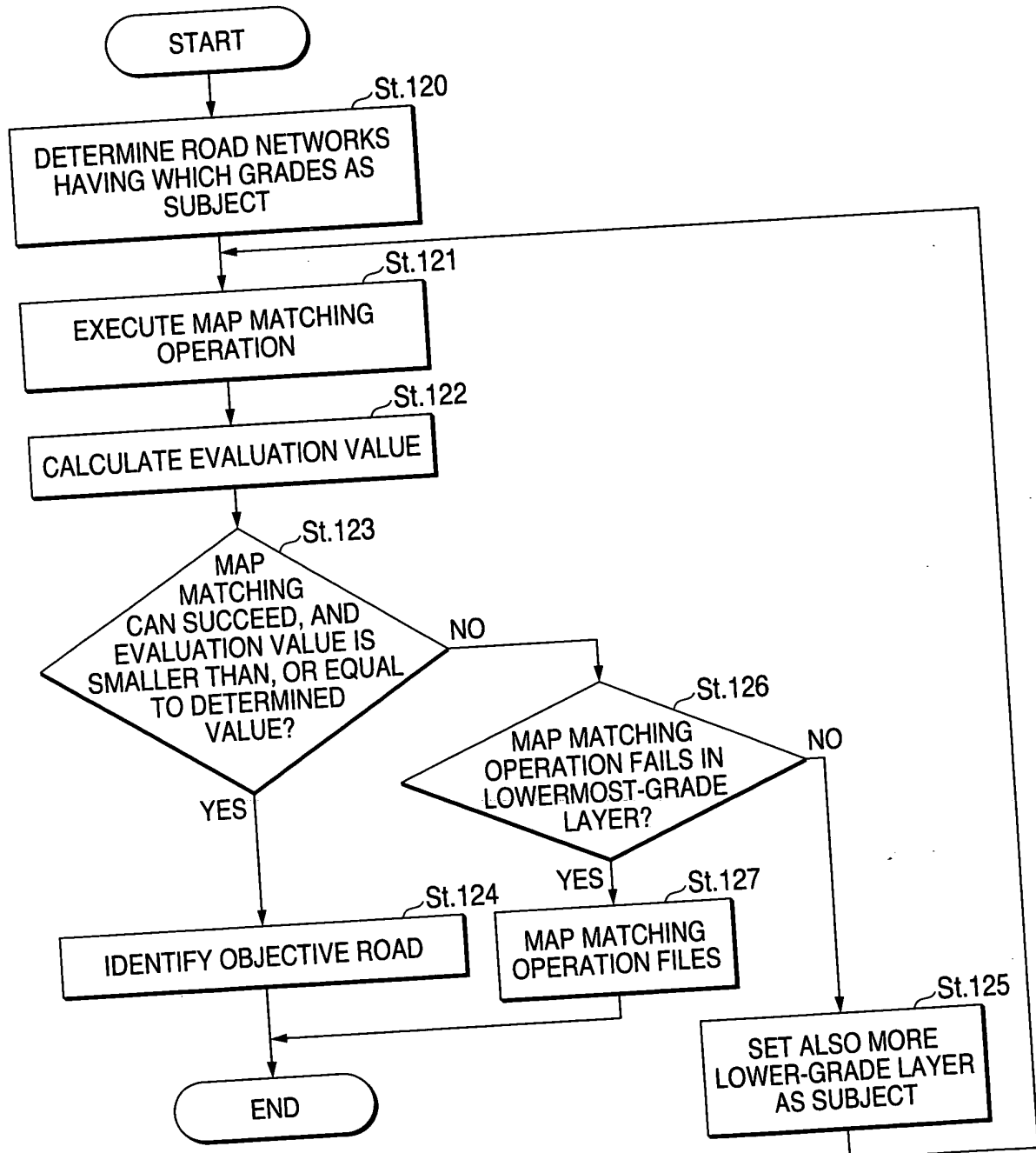


FIG. 39

EXAMPLE IN WHICH PRIORITY ORDERS ARE
APPLIED TO ROADS IN SINGLE LAYER

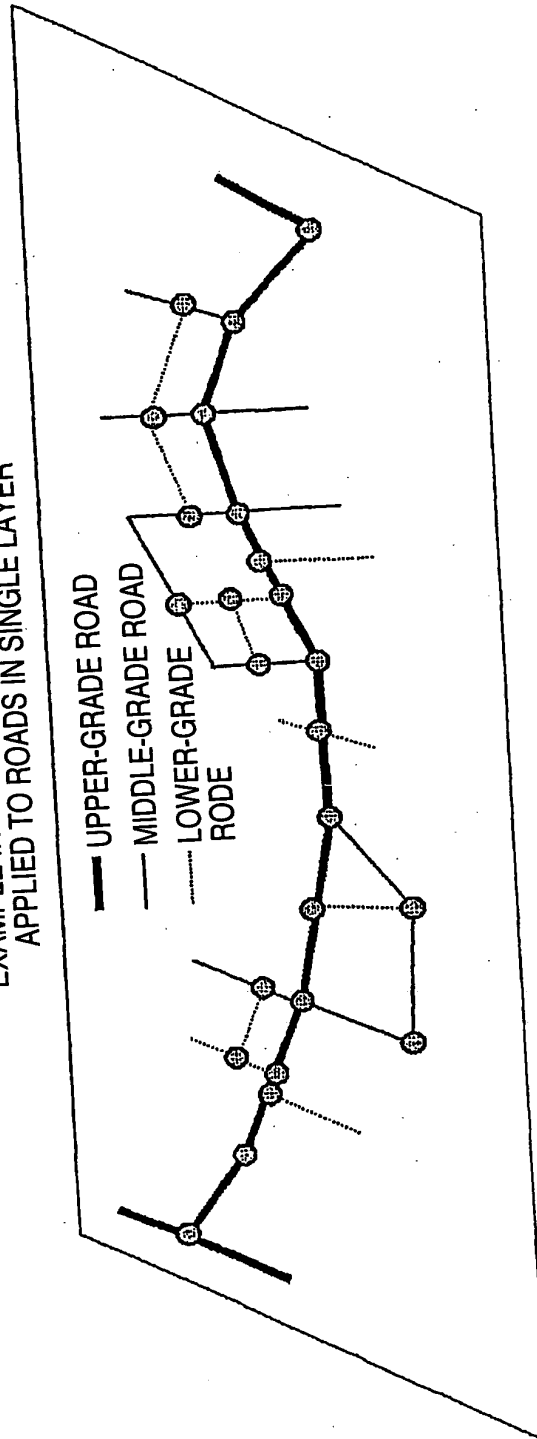


FIG. 40

< HIERARCHICAL LAYER TYPE DATA
PRODUCING PROCESS OPERATION >

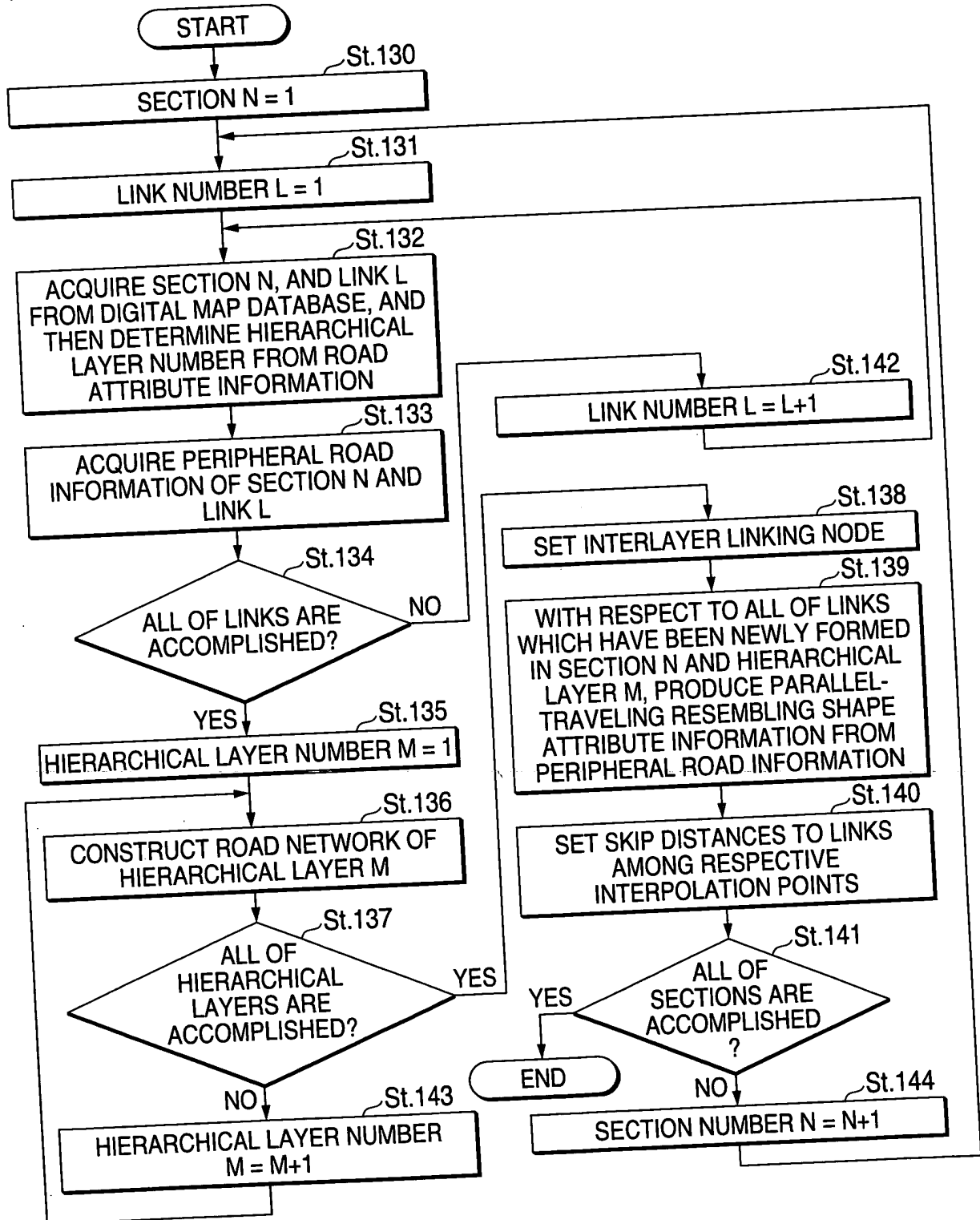
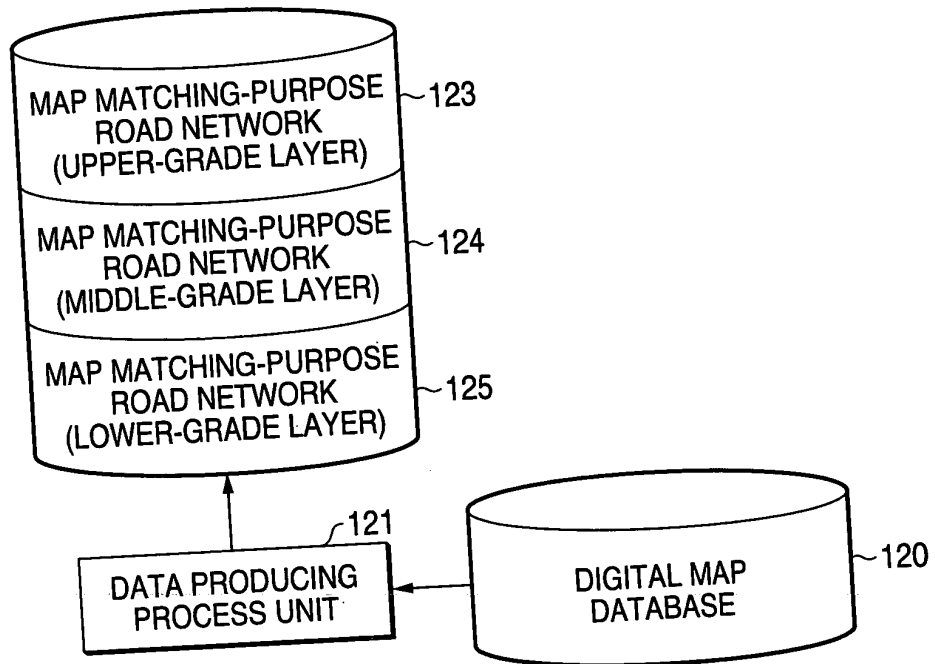


FIG. 41

HIERARCHICAL LAYER TYPE DATA PRODUCING DEVICE

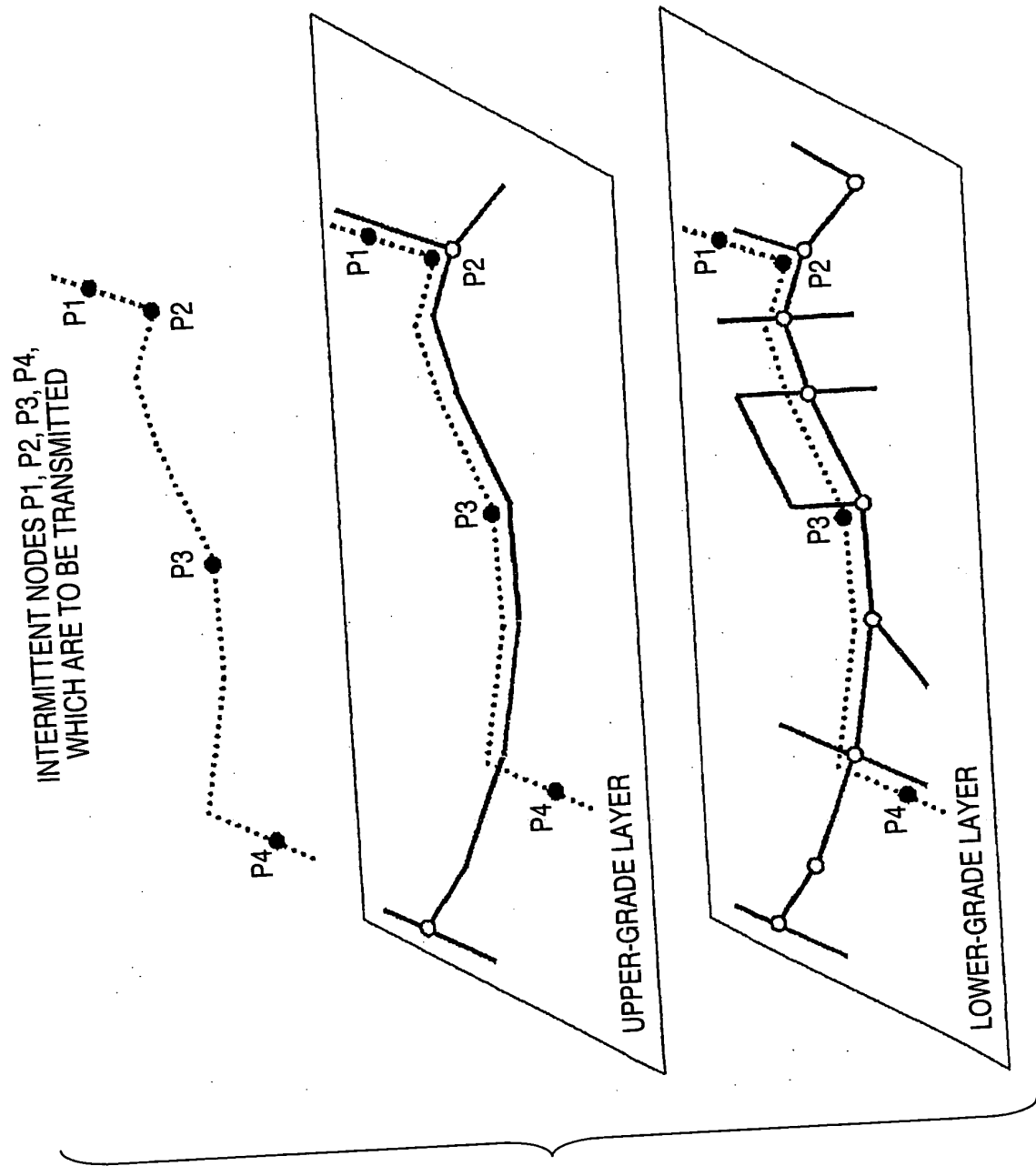


FIG. 42

FIG. 43

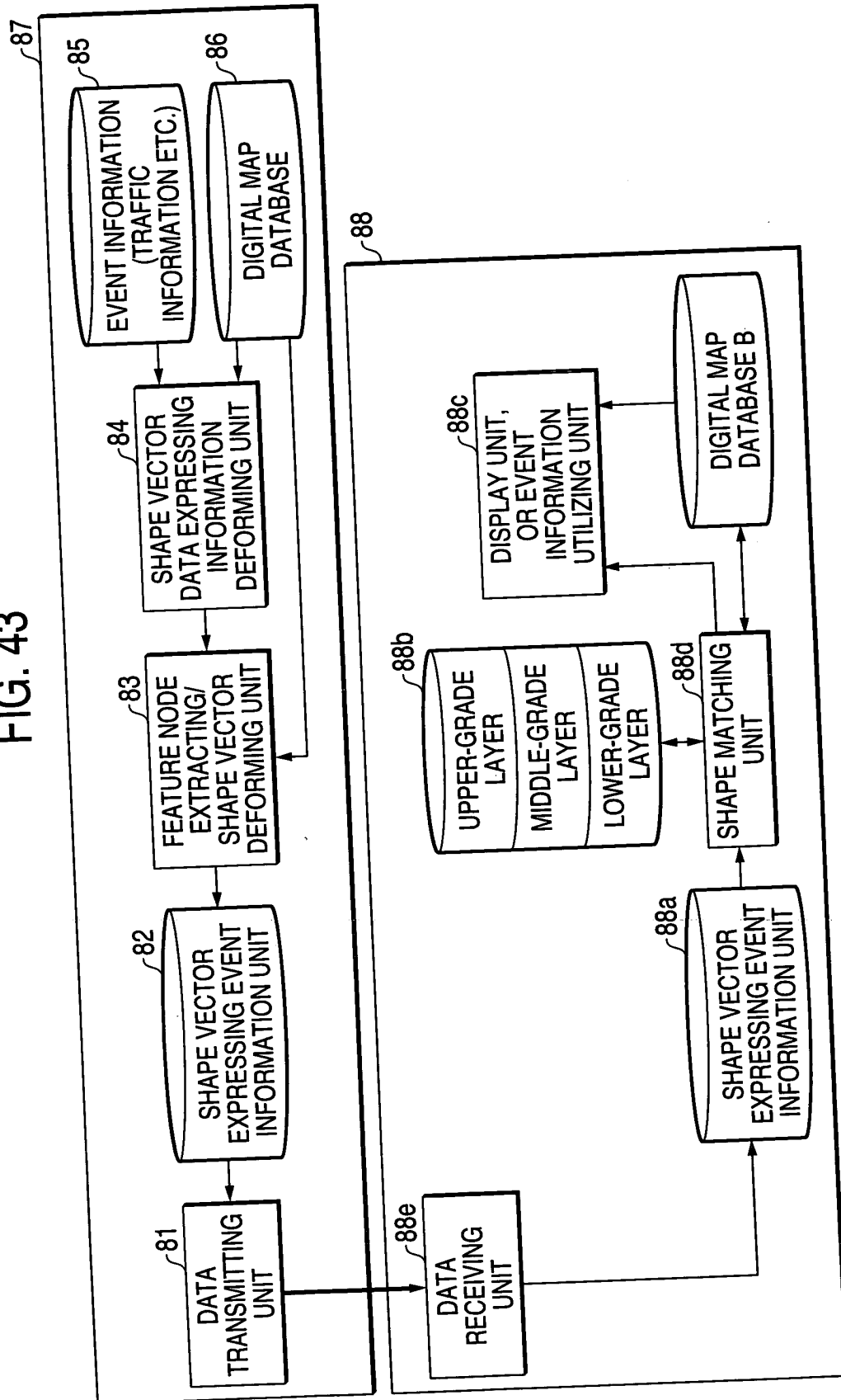


FIG. 44

EVENT INFORMATION

| | |
|---|--------------------------|
| REFERENCE SHAPE VECTOR STREAM NUMBER (= 56) | |
| EVENT 1 (= CLOSED-TO-ALL-VEHICLES EVENT) | |
| DETAILED EVENT INFORMATION (CLOSED-TO-ALL-VEHICLES ETC.) | |
| NODE NUMBER 1 (P_m') | NODE NUMBER 2 (P_n') |
| RELATIVE POSITION OF EVENT FROM P_m' | |
| DIRECTION IDENTIFICATION FLAG (= 1) | |
| ⋮ | |
| EVENT "n" (TRAFFIC JAM) | |
| TRAFFIC JAM DEGREE RANK | |
| NODE NUMBER 1 (P_m') | NODE NUMBER 2 (P_n') |
| EVENT RELATIVE POSITION 1 FROM P_m' (START TERMINAL SIDE OF TRAFFIC JAM) | |
| EVENT RELATIVE POSITION 1 FROM P_m' (END TERMINAL SIDE OF TRAFFIC JAM) | |

SELECT NODES TO BE FEATURED NODES, AND SET SELECTED
NODES TO NODE NUMBERS P_m , P_n , ETC.

FIG. 45

LINK INFORMATION

| |
|---|
| ROAD SORT CODE |
| ROAD NUMBER |
| TOLL ROAD CODE |
| START NODE NUMBER p_4 , AND END NODE NUMBER e_4 |
| BELONGING HIERARCHICAL LAYER: UPPER, MIDDLE, LOWER |
| TOTAL CONNECTION LINK NUMBER l_4 OF p_4 |
| CONNECTION LINK ANGLE 1 OF p_4 |
| ⋮ |
| CONNECTION LINK ANGLE l_4 OF p_4 |
| ⋮ |
| TOTAL CONNECTION LINK NUMBER l_n OF p_m |
| CONNECTION LINK ANGLE 1 OF p_m |
| ... |
| CONNECTION LINK ANGLE l_n OF p_m |

FIG. 46

NODE INFORMATION

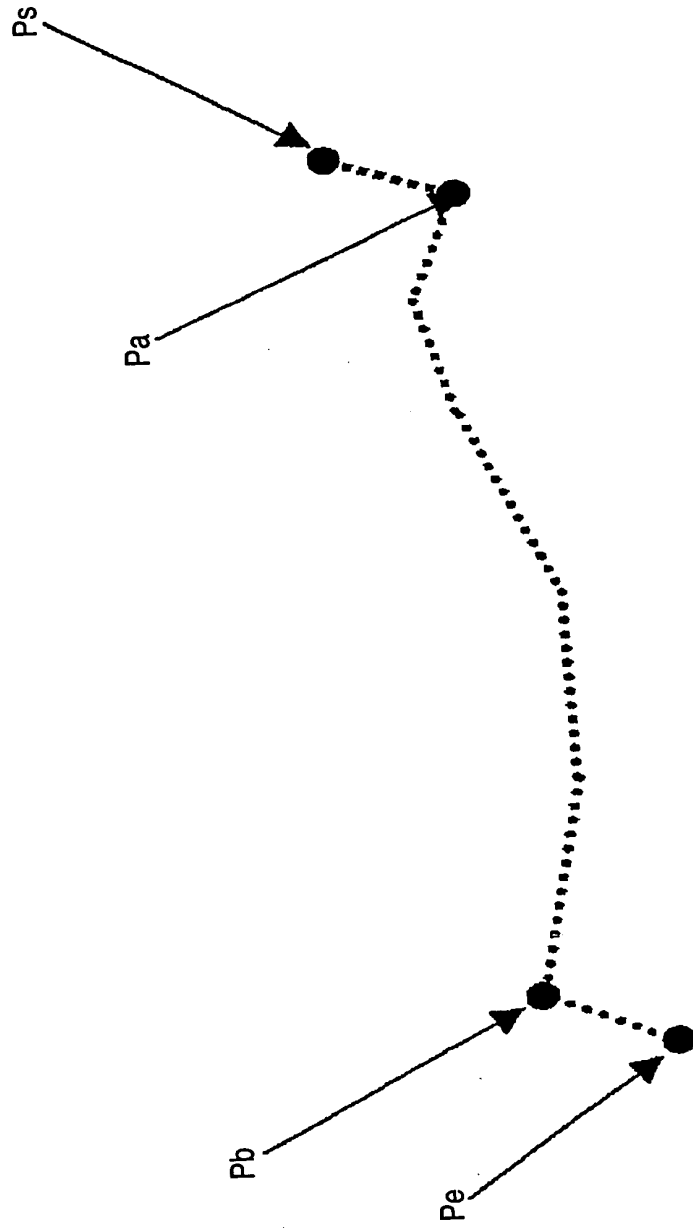
| | |
|---|---|
| VECTOR DATA SORT (= ROAD) | |
| TOTAL NODE NUMBER | |
| BELONGING HIERARCHICAL LAYER INFORMATION | |
| DEFINITION ALONG FORWARD DIRECTION (= 2) | DEFINITION ALONG REVERES DIRECTION (= 1) |
| NODE NUMBER p1 | |
| X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 | |
| Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 | |
| NODE NUMBER p2 | |
| RELATIVE COORDINATE (x2) OF NODE 2 | |
| RELATIVE COORDINATE (y2) OF NODE 2 | |
| ⋮ | |
| NODE NUMBER pn | |
| RELATIVE COORDINATE (xn) OF NODE n | |
| RELATIVE COORDINATE (yn) OF NODE n | |

FIG. 47

SHAPE VECTOR

| |
|---|
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1 |
| VECTOR DATA SORT (= ROAD) |
| BELONGING HIERARCHICAL LAYER (UPPER, MIDDLE, LOWER) |
| TOTAL NODE NUMBER |
| NODE NUMBER p1 |
| X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1 |
| ABSOLUTE AZIMUTH OF NODE 1 |
| ⋮ |
| NODE NUMBER pN |
| RELATIVE COORDINATE (x _n) OF NODE N |
| RELATIVE COORDINATE (y _n) OF NODE N |
| RELATIVE AZIMUTH OF NODE N |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 56 |
| ⋮ ⋮ |
| SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100 |
| ⋮ |

FIG. 48



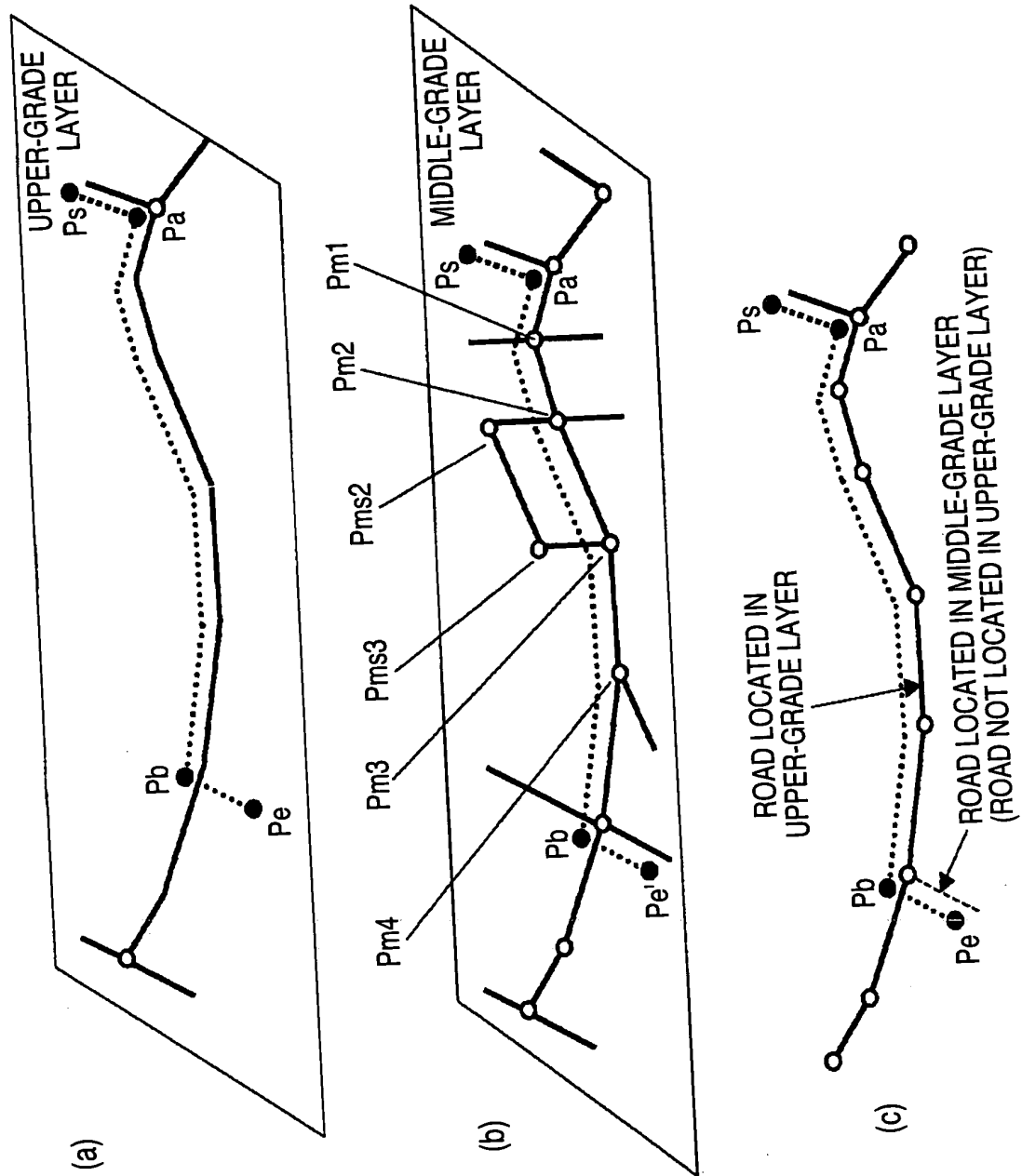
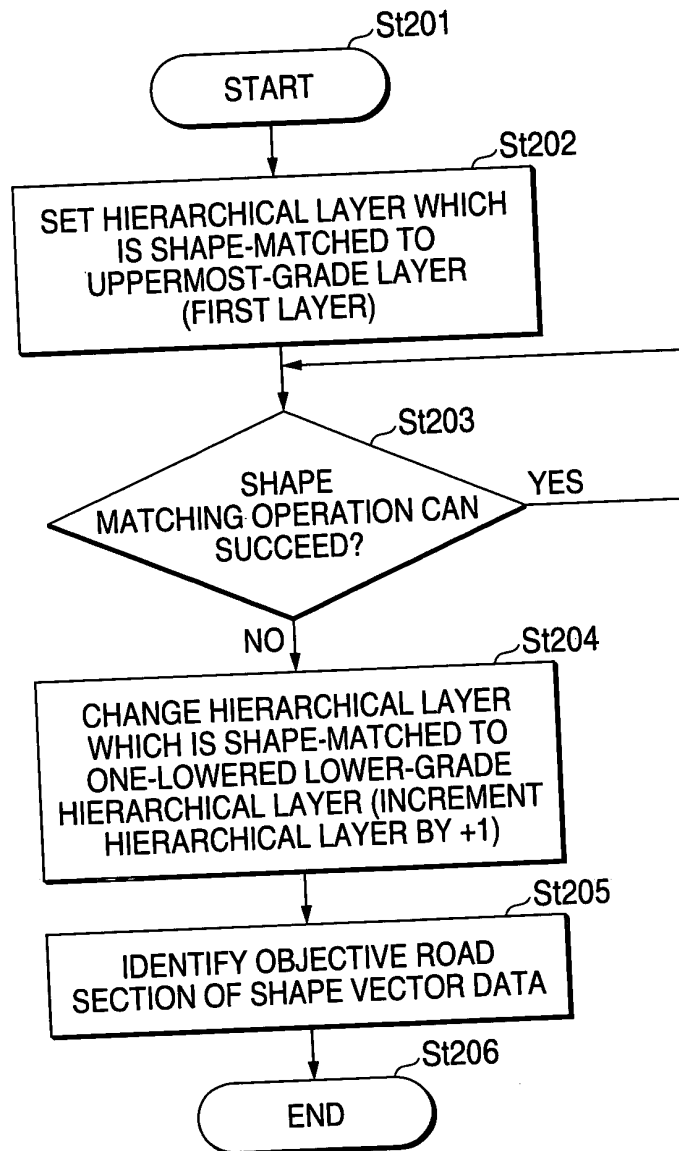


FIG. 49

FIG. 50



58/65

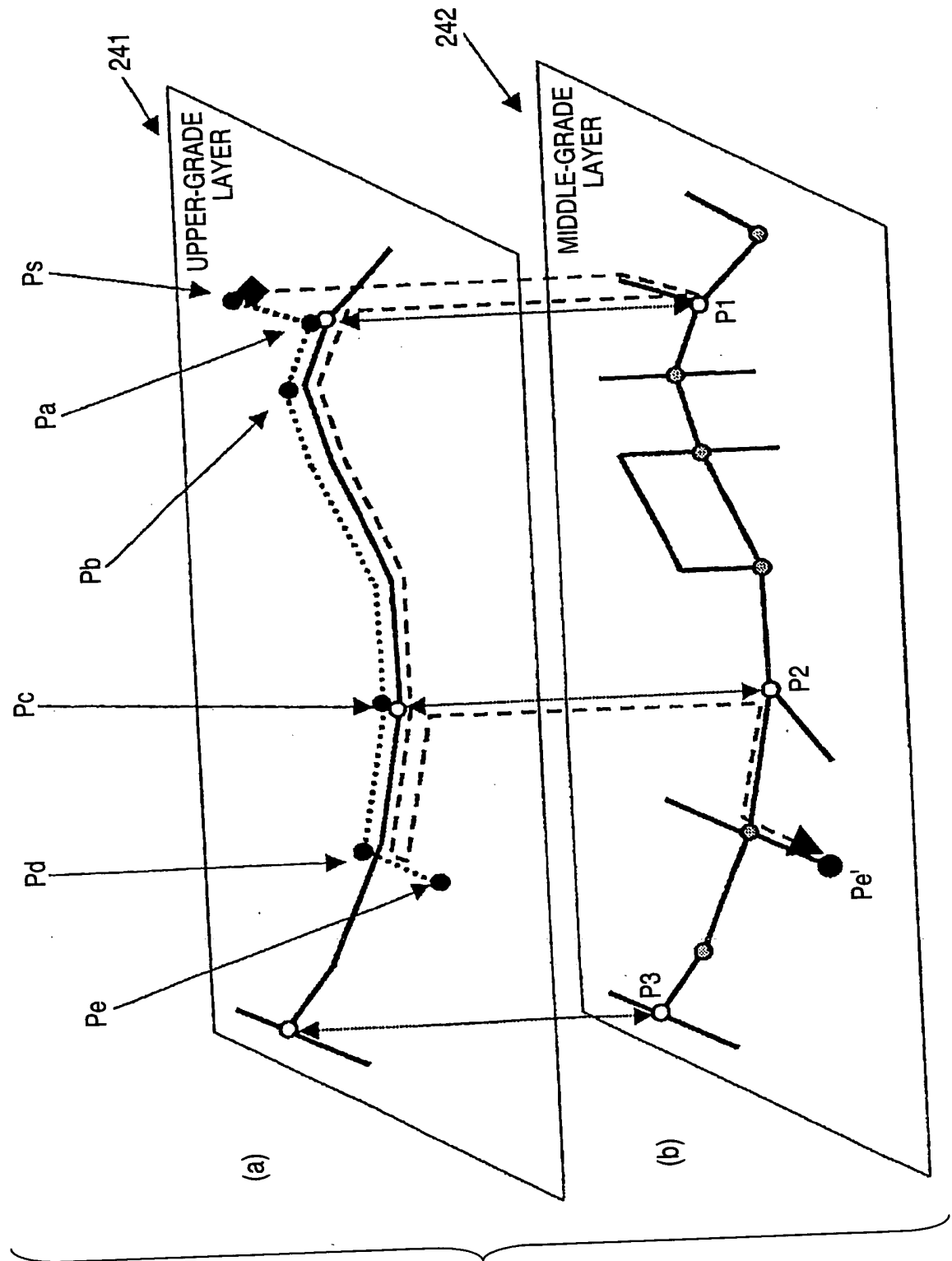


FIG. 51

FIG. 52

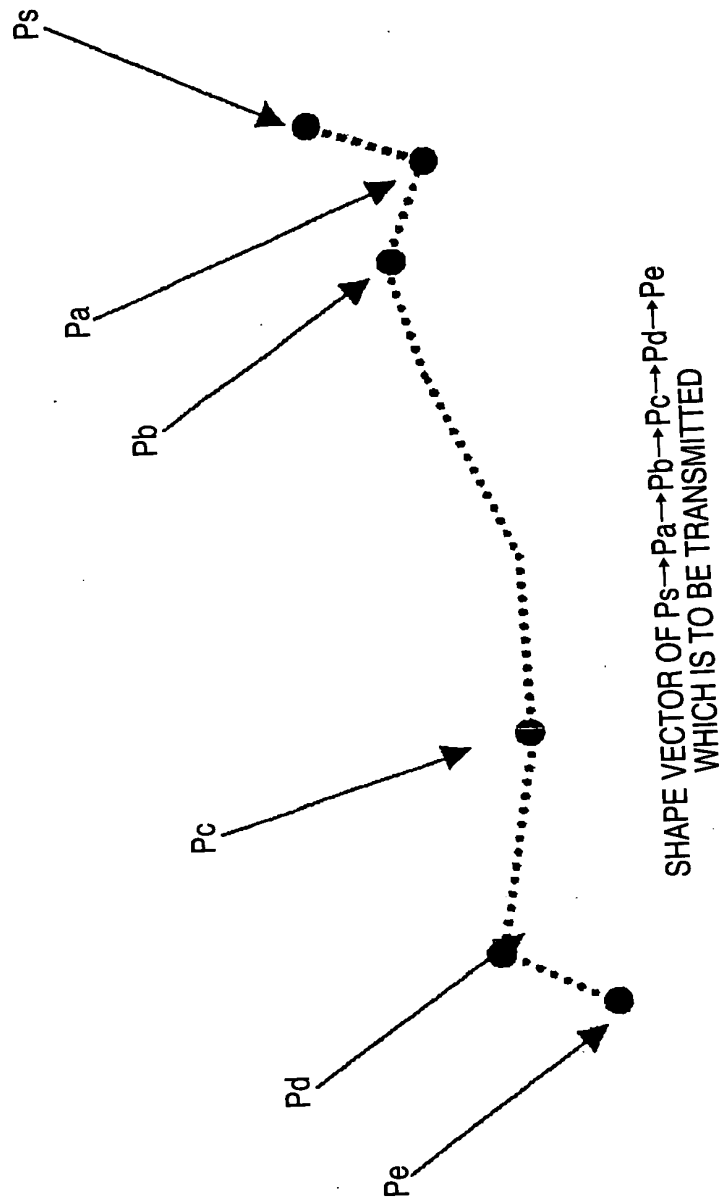
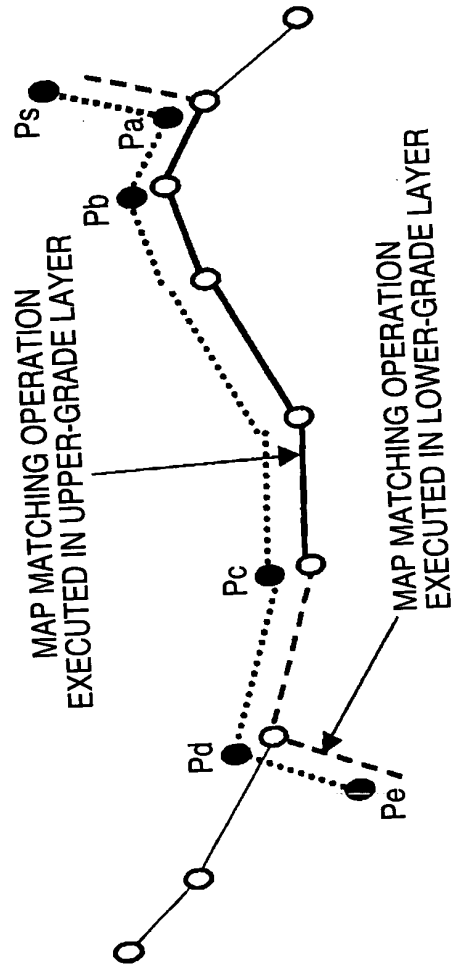


FIG. 53



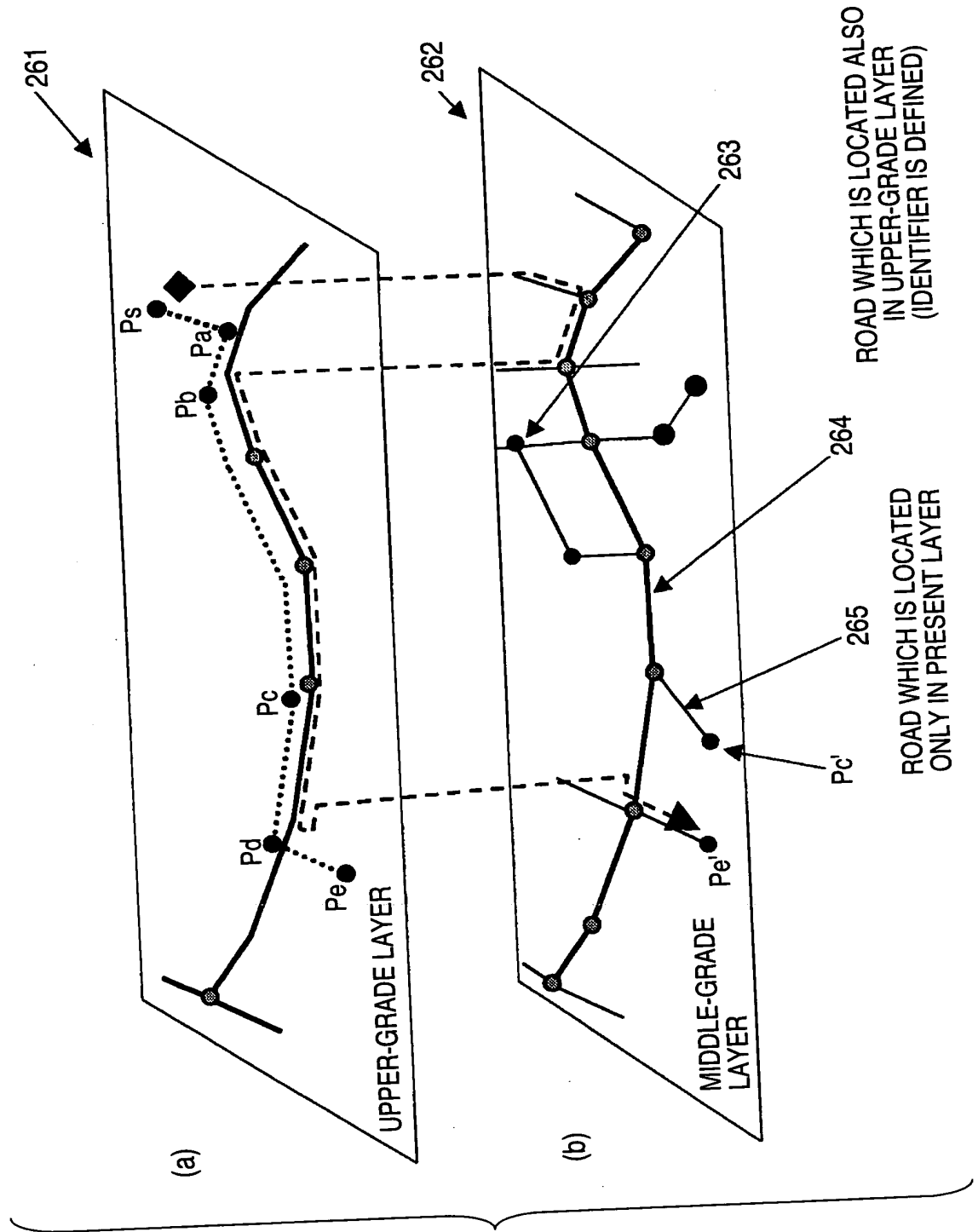


FIG. 54

FIG. 55

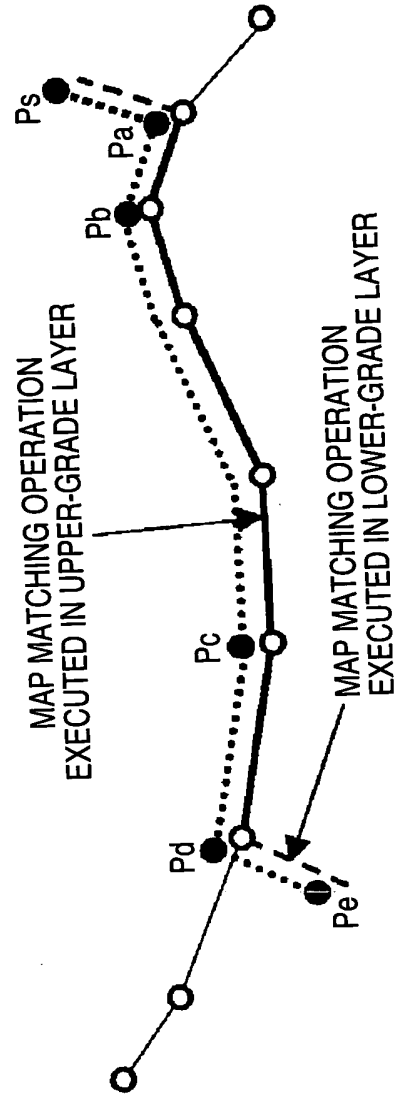


FIG. 56

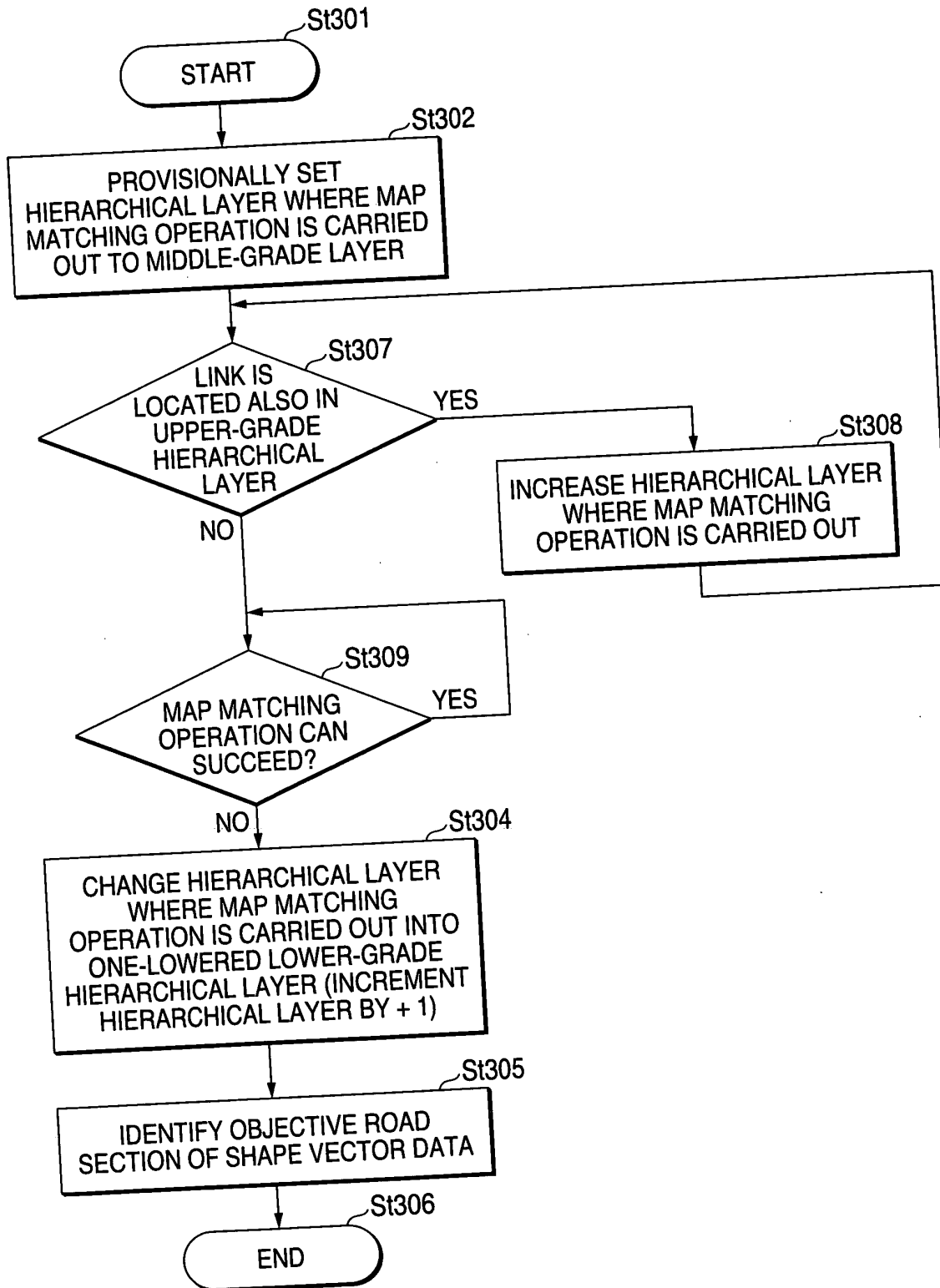


FIG. 57

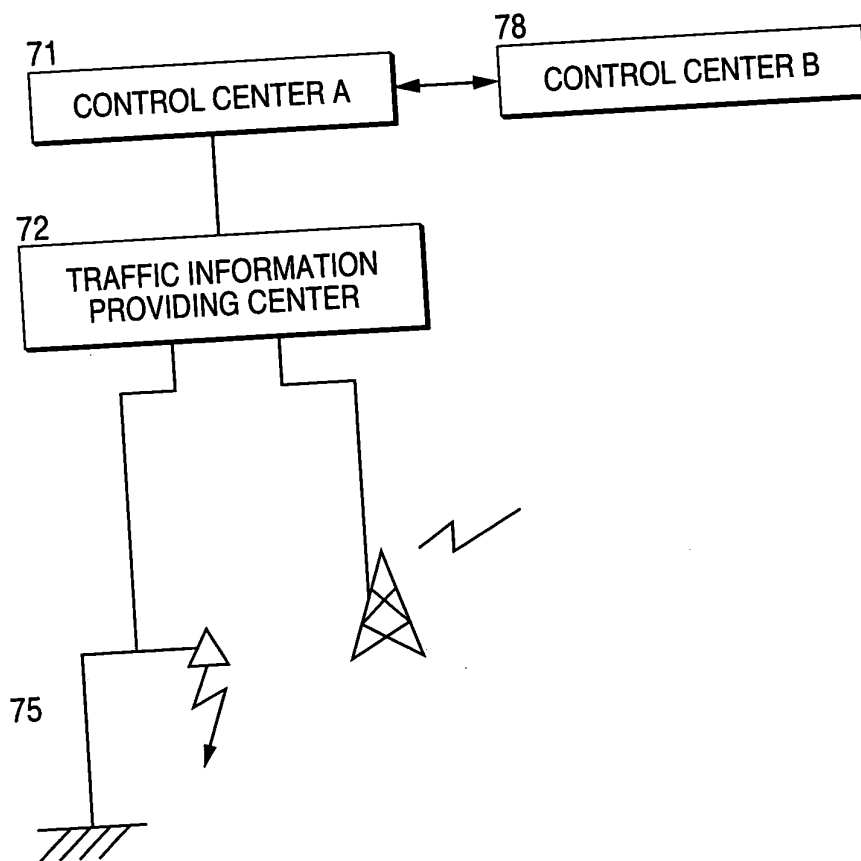


FIG. 58

